



DBAP DEFERRED MAINTENANCE AND IMPROVEMENTS
 BID PACKAGE #2
 CITY OF DURHAM

Volume 2 of 2
PROJECT MANUAL

JULY 19, 2013



TABLE OF CONTENTS

DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS

SECTION 000020 - PROFESSIONAL SEALS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 011000 - SUMMARY
SECTION 012200 - UNIT PRICES
SECTION 012300 - ALTERNATES
SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION
SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION
SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION
SECTION 013300 - SUBMITTAL PROCEDURES
SECTION 014000 - QUALITY REQUIREMENTS
SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS
SECTION 016000 - PRODUCT REQUIREMENTS
SECTION 017300 - EXECUTION
SECTION 017700 - CLOSEOUT PROCEDURES
SECTION 017823 - OPERATION AND MAINTENANCE DATA
SECTION 017839 - PROJECT RECORD DOCUMENTS
SECTION 017900 - DEMONSTRATION AND TRAINING

DIVISION 02 - EXISTING CONDITIONS

SECTION 024116 - STRUCTURE DEMO
SECTION 024119 - SELECTIVE STRUCTURE DEMOLITION

DIVISION 03 - CONCRETE

SECTION 033000 - CAST-IN-PLACE CONCRETE
SECTION 035416 - HYDRAULIC CEMENT UNDERLAYMENT

DIVISION 04 - MASONRY

SECTION 042000 - UNIT MASONRY
SECTION 042113 - BRICK MASONRY
SECTION 047200 - CAST STONE MASONRY

DIVISION 05 - METALS

SECTION 051200 - STRUCTURAL STEEL FRAMING
SECTION 052100 - STEEL JOIST
SECTION 053100 - STEEL DECKING
SECTION 054000 - COLD FORMED METAL FRAMING

SECTION 055000 – METAL FABRICATIONS
SECTION 055100 - METAL STAIRS
SECTION 055213 - PIPE AND TUBE RAILINGS
SECTION 057000 - DECORATIVE METAL
SECTION 057300 - DECORATIVE METAL RAILINGS

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

SECTION 061010 - ROUGH CARPENTRY FOR ROOFING
SECTION 061053 – MISCELLANEOUS ROUGH CARPENTRY
SECTION 061063 – EXTERIOR ROUGH CARPENTRY
SECTION 061600 - SHEATHING
SECTION 062023 - INTERIOR FINISH CARPENTRY
SECTION 064116 - PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 071413 - HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING
SECTION 071816 - PEDESTRIAN TRAFFIC COATINGS
SECTION 071820 - TRAFFIC-BEARING WATERPROOFING SYSTEM
SECTION 071950 - WATER REPELLENT COATINGS
SECTION 072100 - THERMAL INSULATION
SECTION 072270 - THERMAL INSULATION UNIT SYSTEM (IRMA)
SECTION 072413 - POLYMER-BASED EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)
SECTION 074150 - PREFORMED METAL ROOFING REPAIRS
SECTION 075360 - TWO-PLY SBS MODIFIED BITUMEN MEMBRANE ROOF (IRMA)
SECTION 075620 - FLUID-APPLIED ROOFING SYSTEM
SECTION 075710 - ROOFING BALLAST MATERIAL AND PAVER BALLAST SYSTEM
SECTION 076210 - METAL FLASHING AND TRIM
SECTION 076526 - FLASHING SYSTEM FOR VENEER WALLS
SECTION 077200 - ROOF ACCESSORIES
SECTION 078413 - PENETRATION FIRESTOPPING
SECTION 079010 - SEALANTS FOR ROOFING
SECTION 079150 - WATERPROOF EXPANSION JOINT SYSTEM
SECTION 079200 – JOINT SEALANTS
SECTION 079201 - JOINT SEALANTS FOR RESTORATION

DIVISION 08 - OPENINGS

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES
SECTION 081416 - FLUSH WOOD DOORS
SECTION 083113 - ACCESS DOORS AND FRAMES
SECTION 083323 - OVERHEAD COILING DOORS
SECTION 083920 - WATERTIGHT DOORS
SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS
SECTION 085113 - ALUMINUM WINDOWS
SECTION 085653 - SECURITY WINDOWS
SECTION 087111 - DOOR HARDWARE (DESCRIPTIVE SPECIFICATION)
SECTION 088000 - GLAZING
SECTION 088000.01 - GLAZING- IMPACT RESISTANT

SECTION 088300 - MIRRORS
SECTION 089000 - LOUVERS AND VENTS

DIVISION 09 - FINISHES

SECTION 092216 - NON-STRUCTURAL METAL FRAMING
SECTION 092900 - GYPSUM BOARD
SECTION 093000 - TILING
SECTION 095113 - ACOUSTICAL PANEL CEILINGS
SECTION 096400 - WOOD FLOORING
SECTION 096513 - RESILIENT BASE AND ACCESSORIES
SECTION 096519 - RESILIENT TILE FLOORING
SECTION 096723 - RESINOUS FLOORING
SECTION 096813 - TILE CARPETING
SECTION 096816 - SHEET CARPETING
SECTION 097200 - WALL COVERINGS
SECTION 099113 - EXTERIOR PAINTING
SECTION 099123 - INTERIOR PAINTING
SECTION 099726 - SILICATE COATINGS

DIVISION 10 - SPECIALTIES

SECTION 102113 - TOILET COMPARTMENTS
SECTION 102600 - WALL AND DOOR PROTECTION
SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES
SECTION 104410 - INTERIOR UNFRAMED SIGNS
SECTION 104413 - FIRE EXTINGUISHER CABINETS
SECTION 104416 - FIRE EXTINGUISHERS
SECTION 107313 - AWINGS

DIVISION 11 - EQUIPMENT

SECTION 111300 - LOADING DOCK EQUIPMENT
SECTION 114000 - AIR DOORS
SECTION 115213 - PROJECTION SCREENS

DIVISION 12 - FURNISHINGS

SECTION 122413 - ROLLER WINDOW SHADES
SECTION 123661 - SIMULATED STONE COUNTERTOPS

DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 133123 - TENSIONED FABRIC STRUCTURES

DIVISION 14 - CONVEYING EQUIPMENT

SECTION 144200 - WHEELCHAIR LIFTS

DIVISION 21 - FIRE SUPPRESSION

SECTION 211313 - FIRE SPRINKLER SYSTEMS

DIVISION 22 - PLUMBING

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING
SECTION 220505 - EXCAVATION AND BACKFILL
SECTION 220506 - ROOF CURBS AND SUPPORT
SECTION 220510 - PIPE TESTING
SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT
SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING
SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING
SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT
SECTION 220553 - IDENTIFICATION FOR PLUMBING AND EQUIPMENT
SECTION 220700 - PLUMBING INSULATION
SECTION 221113 - FACILITY WATER DISTRIBUTION PIPING
SECTION 221116 - DOMESTIC WATER PIPING
SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES
SECTION 221313 - FACILITY SEWER
SECTION 221316 - SANITARY WASTE AND VENT PIPING
SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES
SECTION 221429 - SUMP PUMPS
SECTION 221603 - FUEL GAS PIPING
SECTION 223400 - FUEL FIRED DOMESTIC WATER HEATERS
SECTION 224000 - PLUMBING FIXTURES

DIVISION 23 - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

SECTION 230500 - COMMON WORK RESULTS
SECTION 230505 - ROOF CURBS AND SUPPORTS
SECTION 230513 - COMMON MOTOR AND CONTROLLER REQUIREMENTS FOR HVAC EQUIPMENT
SECTION 230514 - VARIABLE FREQUENCY DRIVES
SECTION 230516 - PIPE EXPANSION FITTINGS AND LOOP
SECTION 230519 - METERS AND GAGES FOR HVAC PIPING
SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING
SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
SECTION 230533 - HEAT TRACING FOR HVAC PIPING
SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC
SECTION 230700 - HVAC DUCT INSULATION
SECTION 230705 - HVAC PIPE INSULATION
SECTION 230707 - HVAC EQUIPMENT INSULATION
SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC
SECTION 231123 - FACILITY NATURAL-GAS PIPING
SECTION 232113 - HYDRONIC PIPING
SECTION 232123 - HYDRONIC PUMPS
SECTION 232500 - HVAC WATER TREATMENT
SECTION 233113 - METAL DUCTS

SECTION 233300 - AIR DUCT ACCESSORIES
SECTION 233423 - HVAC POWER VENTILATORS
SECTION 233600 - AIR TERMINAL UNITS
SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES
SECTION 234100 - PARTICULATE AIR FILTRATION
SECTION 236423 - AIR COOLED HELICAL ROTARY WATER CHILLERS
SECTION 237313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

DIVISION 26 - ELECTRICAL

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS
SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS
SECTION 260923 - LIGHTING CONTROL DEVICES
SECTION 262200 - DRY TYPE TRANSFORMERS
SECTION 262416 - PANELBOARDS
SECTION 262726 - WIRING DEVICES
SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS
SECTION 265100 - INTERIOR LIGHTING

DIVISION 27 - COMMUNICATIONS

NOT APPLICABLE

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

DIVISION 31 - EARTHWORK

SECTION 311000 - SITE CLEARING
SECTION 312000 - EARTH MOVING

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 321216 - ASPHALT PAVING
SECTION 321313 - CONCRETE PAVING
SECTION 321373 - CONCRETE JOINTS
SECTION 321400 - UNIT PAVERS
SECTION 321805 - PLAYING FIELD EARTHWORK
SECTION 321806 - PLAYING FIELD SUB DRAINAGE SYSTEMS
SECTION 321808 - PLAYING FIELD IRRIGATION SYSTEMS
SECTION 321811 - PLAYING FIELD SAND ROOT ZONE AND BASEBALL MIXTURES
SECTION 321813 - PLAYING FIELD SOD
SECTION 321923 - TREE PIT ROOT PATH
SECTION 323113 - CHAINLINK FENCE
SECTION 328400 - IRRIGATION

SECTION 329300 - PLANTS

DIVISION 33 - UTILITIES

SECTION 334100 – STORM PIPE

SECTION 211313 - FIRE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Fire-department connections.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Pressure gages.

1.3 DEFINITIONS

- A. Working Plans: Documents, including drawings, calculations, and material specifications prepared according to NFPA 13 for obtaining approval from authorities having jurisdiction.
- B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum

1.4 SYSTEM PERFORMANCE REQUIREMENTS

- A. Design sprinklers and obtain approval from authorities having jurisdiction.
- B. Design sprinkler piping according to the following and obtain approval from authorities having jurisdiction:
 - 1. Include 10 percent margin of safety for available water flow and pressure.
 - 2. Include losses through water-service piping, valves, and backflow preventers.
 - 3. Sprinkler Occupancy Hazard Classifications: As follows per NFPA 13:
 - a. Electrical Equipment Rooms: Ordinary Hazard, Group 2.
 - b. Mechanical Equipment Rooms: Ordinary Hazard, Group 2.
 - c. Storage, Laundry, and Recycle Rooms: Ordinary Hazard, Group 1
 - d. Offices, Lobbies, Lounges, Corridors: Light Hazard.
 - e. Minimum Density for Automatic-Sprinkler Piping Design: Per NFPA 13.
 - 4. Maximum Protection Area per Sprinkler: Per NFPA 13.

- C. Components and Installation: Capable of producing piping systems with 175-psig minimum working-pressure rating, unless otherwise indicated.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Pipe and fitting materials and methods of joining for sprinkler piping.
 - 2. Pipe hangers and supports.
 - 3. Valves, including specialty valves, accessories, and devices.
 - 4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
- B. Fire-Hydrant Flow Test Report: As specified in "Preparation" Article.
- C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction. Include hydraulic calculations.
- D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Domestic water piping.
 - 2. Natural Gas piping.
 - 3. HVAC hydronic piping.
 - 4. HVAC Duct and equipment.
 - 5. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Fire Alarm devices.
- E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- F. Maintenance Data: For each sprinkler specialty to include in maintenance manuals specified in Division 1.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has designed and installed fire-suppression piping similar to that indicated for this Project and obtained design approval and inspection approval from authorities having jurisdiction.
- B. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer or NICET Level 3 certified technician. Base calculations on results of fire-hydrant flow test.

- C. Professional Engineer (or NICET Level 3 Technician) Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of fire-suppression piping that are similar to those indicated for this Project in material, design, and extent.
- D. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- E. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with other requirements indicated.
- F. Sprinkler Components: Listing/approval stamp, label, or other marking by a testing agency acceptable to authorities having jurisdiction.
- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- H. NFPA Standards: Equipment, specialties, accessories, installation, and testing complying with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."

1.7 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounting steel cabinet and hinged cover, with space for a minimum of six spare sprinklers plus sprinkler wrench. Include the number of sprinklers required by NFPA 13 and wrench for sprinklers. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Specialty Valves and Devices:
 - a. Badger Fire Protection, Inc.
 - b. Central Sprinkler Corp.
 - c. Firematic Sprinkler Devices, Inc.
 - d. Globe Fire Sprinkler Corp.
 - e. Grinnell Corp.
 - f. Reliable Automatic Sprinkler Co., Inc.
 - g. Star Sprinkler Corp.
 - h. Viking Corp.
2. Water-Flow Indicators and Supervisory Switches:
 - a. Gamewell Co.
 - b. Grinnell Corp.
 - c. Pittway Corp.; System Sensor Div.
 - d. Potter Electric Signal Co.
 - e. Reliable Automatic Sprinkler Co., Inc.
 - f. Viking Corp.
 - g. Watts Industries, Inc.; Water Products Div.
3. Sprinkler, Drain and Alarm Test Fittings:
 - a. Central Sprinkler Corp.
 - b. Fire-End and Croker Corp.
 - c. Grinnell Corp.
 - d. Victaulic Co. of America.
4. Sprinkler, Branch-Line Test Fittings:
 - a. Elkhart Brass Mfg. Co., Inc.
 - b. Fire-End and Croker Corp.
 - c. Smith Industries, Inc.; Potter-Roemer Div.
5. Sprinkler, Inspector's Test Fittings:
 - a. Fire-End and Croker Corp.
 - b. G/J Innovations, Inc.
 - c. Triple R Specialty of Ajax, Inc.
6. Sprinklers:
 - a. Badger Fire Protection, Inc.
 - b. Central Sprinkler Corp.
 - c. Firematic Sprinkler Devices, Inc.
 - d. Globe Fire Sprinkler Corp.
 - e. Grinnell Corp.
 - f. Reliable Automatic Sprinkler Co., Inc.
 - g. Star Sprinkler Corp.
 - h. Viking Corp.
7. Fire-Protection-Service Valves:

- a. Central Sprink, Inc.
- b. Central Sprinkler Corp.
- c. Grinnell Corp.
- d. McWane, Inc.; Kennedy Valve Div.
- e. Nibco, Inc.
- f. Stockham Valves & Fittings, Inc.
- g. Victaulic Co. of America.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PIPES

- A. Standard-Weight Steel Pipe: ASTM A 53, ASTM A 135, or ASTM A 795; Schedule 40 in NPS 6 and smaller, and Schedule 30 in NPS 8 and larger.
- B. Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 (DN125) and smaller and NFPA 13 specified wall thickness in NPS 6 to NPS 10.

2.4 PIPE FITTINGS

- A. Cast-Iron Threaded Flanges: ASME B16.1.
- B. Cast-Iron Threaded Fittings: ASME B16.4.
- C. Malleable-Iron Threaded Fittings: ASME B16.3.
- D. Steel, Threaded Couplings: ASTM A 865.
- E. Steel Welding Fittings: ASTM A 234/A 234M, ASME B16.9, or ASME B16.11.
- F. Steel Flanges and Flanged Fittings: ASME B16.5.
- G. Steel, Grooved-End Fittings: UL-listed and FM-approved, ASTM A 47 (ASTM A 47M), malleable iron or ASTM A 536, ductile iron; with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

2.5 JOINING MATERIALS

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for pipe-flange gasket materials and welding filler metals.
- B. Ductile-Iron, Keyed Couplings: UL 213 and AWWA C606, for ductile-iron pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gaskets, and steel bolts and nuts.

- C. Ductile-Iron, Flanged Joints: AWWA C115, ductile-iron or gray-iron pipe flanges, rubber gaskets, and steel bolts and nuts.
- D. Transition Couplings: AWWA C219, sleeve type, or other manufactured fitting the same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

2.6 GENERAL-DUTY VALVES

- A. Refer to Division 22 Section "Valves" for gate, ball, butterfly, globe, and check valves not required to be UL listed and FM approved.

2.7 FIRE-PROTECTION-SERVICE VALVES

- A. General: UL listed and FM approved, with minimum 175-psig nonshock working-pressure rating. Valves for grooved-end piping may be furnished with grooved ends instead of type of ends specified.
- B. Gate Valves, NPS 2 and Smaller: UL 262; cast-bronze, threaded ends; solid wedge; OS&Y; and rising stem.
- C. Indicating Valves, NPS 2-1/2 and Smaller: UL 1091; butterfly or ball-type, bronze body with threaded ends; and integral indicating device.
 - 1. Indicator: Electrical 115-V ac, prewired supervisory switch.
- D. Gate Valves, NPS 2-1/2 and Larger: UL 262, iron body, bronze mounted, taper wedge, OS&Y, and rising stem. Include replaceable, bronze, wedge facing rings and flanged ends.
- E. Swing Check Valves, NPS 2 and Smaller: UL 312 or MSS SP-80, Class 150; bronze body with bronze disc and threaded ends.
- F. Swing Check Valves, NPS 2-1/2 and Larger: UL 312, cast-iron body and bolted cap, with bronze disc or cast-iron disc with bronze-disc ring and flanged ends.
- G. Split-Clapper Check Valves, NPS 4 and Larger: UL 312, cast-iron body with rubber seal, bronze-alloy discs, and stainless-steel spring and hinge pin.

2.8 SPRINKLERS

- A. Automatic Sprinklers: With heat-responsive element complying with the following:
 - 1. UL 199, for applications except for ESFR.
 - 2. UL 1767, for early suppression, fast-response applications.
- B. Sprinkler Types and Categories: Nominal 1/2-inch (12.7-mm) orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.

- a. Orifice: 1/2 inch (12.7 mm), with discharge coefficient K between 5.3 and 5.8.
 - b. Orifice: 17/32 inch (13.5 mm), with discharge coefficient K between 7.4 and 8.2.
- C. Sprinkler types, features, and options include the following:
 - 1. Pendent sprinklers.
 - 2. Pendent, dry-type sprinklers.
 - 3. Recessed sprinklers, including escutcheon.
 - 4. Sidewall sprinklers.
 - 5. Sidewall, dry-type sprinklers.
 - 6. Upright sprinklers.
 - 7. ESFR sprinklers.
- D. Sprinkler Finishes: Chrome-plated, bronze, and painted.
- E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 - 1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
 - 2. Ceiling Mounting: Chrome-plated steel, two-piece recessed, with 1/2-inch vertical adjustment.
 - 3. Sidewall Mounting: Chrome-plated steel, one piece, flat.
- F. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.9 SPECIALTY SPRINKLER FITTINGS

- A. Specialty Fittings: UL listed and FM approved; made of steel, ductile iron, or other materials compatible with piping.
- B. Locking-Lug Fittings: UL 213, ductile-iron body with locking-lug ends.
- C. Mechanical-T Fittings: UL 213, ductile-iron housing with pressure-responsive gasket, bolts, and threaded or locking-lug outlet.
- D. Mechanical-Cross Fittings: UL 213, ductile-iron housing with pressure-responsive gaskets, bolts, and threaded or locking-lug outlets.
- E. Drop-Nipple Fittings: UL 1474, with threaded inlet, threaded outlet, and seals; adjustable.
- F. Sprinkler, Drain and Alarm Test Fittings: UL-listed, cast- or ductile-iron body; with threaded inlet and outlet, test valve, and orifice and sight glass.
- G. Sprinkler, Branch-Line Test Fittings: UL-listed, brass body; with threaded inlet and capped drain outlet and threaded outlet for sprinkler.
- H. Sprinkler, Inspector's Test Fittings: UL-listed, cast- or ductile-iron housing; with threaded inlet and drain outlet and sight glass.

2.10 ALARM DEVICES

- A. General: Types matching piping and equipment connections.
- B. Water-Motor-Operated Alarms: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch-diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 inlet and NPS 1 drain connections.
- C. Water-Flow Indicators: UL 346; electrical-supervision, vane-type water-flow detector; with 250-psig pressure rating; and designed for horizontal or vertical installation. Include two single-pole, double-throw, circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
- D. Pressure Switches: UL 753; electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
- E. Valve Supervisory Switches: UL 753; electrical; single-pole, double throw; with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

2.11 PRESSURE GAGES

- A. Pressure Gages: UL 393, 3-1/2- to 4-1/2-inch- diameter dial with dial range of 0 to 250 psig.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article in Part 1 of this Section.
- B. Report test results promptly and in writing.

3.2 EXAMINATION

- A. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PIPING APPLICATIONS

- A. Do not use welded joints with galvanized steel pipe.
- B. Flanges, unions, and transition and special fittings with pressure ratings the same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- C. Sprinklers: Use the following:
- D. Wet-Pipe Sprinklers: Use the following:
 - 1. NPS 1-1/2: and Smaller: Standard-weight steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.
 - 2. NPS 2: Standard-weight steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.
 - 3. NPS 2-1/2 to NPS 3-1/2: Schedule 10 steel pipe with roll-grooved ends; steel, grooved-end fittings; and grooved joints.
 - 4. NPS 4: Schedule 10 steel pipe with roll-grooved ends; steel, grooved-end fittings; and grooved joints.
 - 5. NPS 5 and NPS 6: Schedule 10 steel pipe with roll-grooved ends; steel, grooved-end fittings; and grooved joints.
- E. Dry Sprinklers: Use the following: Same as for wet-pipe indicated above, but galvanized piping.

3.4 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Fire-Protection-Service Valves: UL listed and FM approved for applications where required by NFPA 13 and NFPA 14.
 - a. Shutoff Duty: Use gate valves.
 - 2. General-Duty Valves: For applications where UL-listed and FM-approved valves are not required by NFPA 13 and NFPA 14.
 - a. Shutoff Duty: Use gate, ball, or butterfly valves.
 - b. Throttling Duty: Use globe, ball, or butterfly valves.

3.5 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Ductile-Iron-Piping, Grooved Joints: Use ductile-iron pipe with radius-cut-grooved ends; ductile-iron, grooved-end fittings; and ductile-iron, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.

- C. Steel-Piping, Grooved Joints: Use Schedule 40 steel pipe with cut or roll-grooved ends and Schedule 30 or thinner steel pipe with roll-grooved ends; steel, grooved-end fittings; and steel, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions. Use gaskets listed for dry-pipe service for dry piping.

3.6 PIPING INSTALLATION

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping installation.
- B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
- E. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
- F. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- I. Install drain valves on standpipes.
- J. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
- K. Install alarm devices in piping systems.
- L. Hangers and Supports: Comply with NFPA 13 for hanger materials. Install according to NFPA 13 for sprinkler piping and to NFPA 14 for standpipes.
- M. Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated.
- N. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4

and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

3.7 VALVE INSTALLATION

- A. Refer to Division 22 Section "Valves" for installing general-duty valves. Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13 and NFPA 14, manufacturer's written instructions, and authorities having jurisdiction.
- B. Gate Valves: Install fire-protection-service valves supervised-open, located to control sources of water supply except from fire department connections. Provide permanent identification signs indicating portion of system controlled by each valve.

3.8 SPRINKLER APPLICATIONS

- A. General: Use sprinklers according to the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Recessed sprinklers.
 - a. Upright, Pendent, ESFR, and Sidewall Sprinklers: Chrome-plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
 - b. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.

3.9 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical panels and tiles.
- B. Install recessed style sprinklers in the mid-range of available adjustment. All installed recessed sprinklers shall have equal recess – tolerance of plus or minus 1/8" inch.
- C. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.10 CONNECTIONS

- A. Electrical Connections: Power wiring is specified in Division 26.
- B. Connect alarm devices to fire alarm.

3.11 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece or split casting, cast brass with polished chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
5. Bare Piping in Equipment Rooms: One piece, cast brass with polished chrome-plated finish.
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.12 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and in Division 22 Section "Mechanical Identification."

3.13 FIELD QUALITY CONTROL

- A. Flush, test, and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.
- B. Flush, test, and inspect underground piping according to NFPA 24.
- C. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
- D. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.14 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers having paint other than factory finish.

3.15 PROTECTION

- A. Protect sprinklers from damage until Substantial Completion.

3.16 COMMISSIONING

- A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
- B. Verify that specified tests of piping are complete.

- C. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.
- D. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.
- E. Verify that potable-water supplies have correct types of backflow preventers.
- F. Drain dry-pipe sprinkler piping.
- G. Verify that hose connections and fire department connections have threads compatible with local fire department equipment.
- H. Fill wet-pipe sprinkler piping with water.
- I. Verify that hose connections are correct type and size.
- J. Energize circuits to electrical equipment and devices.
- K. Coordinate with fire alarm tests. Operate as required.

3.17 DEMONSTRATION

- A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.

3.20 PAINTING

- A. Paint all exposed sprinkler piping bright red, one coat of primer, two coats of enamel.

END OF SECTION 211313

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Grout.
7. Plumbing demolition.
8. Equipment installation requirements common to equipment sections.
9. Concrete bases.
10. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 QUALITY ASSURANCE

- A. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.4 COORDINATION OF TRADES

- A. Check, verify and coordinate work with other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with the building structure or other trades.
- B. Drawings and specifications are necessarily schematic in nature and cannot describe completely all situations that might be encountered in the field. It is the responsibility of the contractor to familiarize himself with the scope of work required and include all work indicated or reasonably implied by the contract documents.
- C. Layout the work to prevent conflict with, and to co-ordinate with work of other trades. Systems shall generally be run in a rectilinear fashion.
- D. Each trade is responsible for the coordination of their work with all other work at the site prior to beginning in each area.
- E. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- F. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- G. Coordinating space requirements, supports, and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- H. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

- F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

1.6 DIVISION OF WORK (Division 22/26)

- A. This section delineates the division of work between Division 22 and Division 26.
- B. Specific work to be done under Division 26 is hereinafter listed or described. All other work necessary for the operation of Division 22 equipment shall be performed under Division 22.
- C. All individual motor starters for mechanical equipment (fans, pumps, etc.) shall be furnished and installed under Division 22 unless indicated as a part of a motor control center. Motor starters for mechanical equipment provided in motor control centers shall be furnished under Division 26.
- D. Under Division 26, power wiring shall be provided up to a termination point consisting of a junction box, trough, starter or disconnect switch. Under Division 26 line side terminations shall be provided. Wiring from the termination point to the mechanical equipment, including final connections, shall be provided under Division 22.
- E. Duct smoke detectors shall be furnished and wired by Division 26, installed by Division 22. Fire alarm AHU shut down circuits shall be wired from the fire alarm control panel to a termination point, adjacent to the AHU control, under Division 26. AHU control wiring from the termination point to the equipment shall be under Division 22.
- F. All relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric, and electric-pneumatic switches, aquastats, freezestats, line and low voltage thermostats, thermals, remote selector switches, remote pushbutton stations, emergency break-glass stations, interlocking, disconnect switches beyond termination point, and other appurtenances associated with equipment under Division 22 shall be furnished, installed and wired under Division 22.
- G. All wiring required for controls and instrumentation not indicated on the drawings shall be furnished and installed by Division 22.
- H. Roof exhaust fans with built-in disconnects provided under Division 22 shall be wired under Division 26 to the line side of the disconnect switch. A disconnect switch shall be provided under Division 26 if the fan is not provided with a built-in disconnect switch. In this case wiring from the switch to the fan shall be under Division 22.

- I. The sequence of control for all equipment shall be as indicated on the Division 22 Drawings and specified in Section, HVAC Control System.
- J. Where electrical wiring is required by trades other than covered by Division 26, specifications for that section shall refer to same wiring materials and methods as specified under Division 26. No Exceptions.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

2.2 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

2.5 SLEEVES

- A. Provide sleeves for all pipe penetrations of walls, partitions, and floors.

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install escutcheons for penetrations of walls, ceilings, and floors.
- I. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- J. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- K. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to Division 22 Sections specifying piping systems.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- B. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Attach to substrates as required to support applied loads.

3.9 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

3.10 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair cut surfaces to match adjacent surfaces. Execute cutting and patching including excavation and fill to complete the work, to uncover work to install improperly sequenced work, to remove and replace defective or non-conforming work, to remove samples of installed work for testing when requested, to provide openings in the work for penetration of mechanical and electrical work, to execute patching to complement adjacent work, and to fit Products together to integrate with other work.
- C. Execute work by methods to avoid damage to other work, and which will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- D. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- E. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- F. Restore work with new Products in accordance with requirements of Contract Documents.
- G. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- H. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material, to full thickness of the penetrated element.
- I. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

END OF SECTION 220500

SECTION 220505 - EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Excavating and backfilling trenches within building lines.
 - 2. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.
- B. Related Sections include the following:
 - 1. Division 23 and 26 Sections for excavating and backfilling buried mechanical and electrical utilities and buried utility structures.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Each type of plastic warning tape.

1.4 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated:
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

3.2 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
 1. Clearance: 12 inches on each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 1. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
 3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.3 UTILITY TRENCH BACKFILL

- A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

- B. Place and compact initial backfill of subbase material, free of particles larger than 1 inch, to a height of 12 inches over the utility pipe or conduit.
 - 1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
- C. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.4 COMPACTION OF BACKFILLS

- A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

3.5 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 220505

SECTION 220506 – ROOF CURBS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:

1. Roof curbs.
2. Equipment supports.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, materials, dimensions of individual components and profiles, and finishes.

1.3 QUALITY ASSURANCE

- A. Standards: Comply with the following:

1. SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.
2. NRCA's "Roofing and Waterproofing Manual" details for installing units.

- B. Coordinate roof curbs and flashing with the roofing system approved installation procedures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Roof Curbs and Equipment Supports:
 - a. Pate Co.(The)
 - b. Loren Cook Company.
 - c. Roof Products & Systems Corp.
 - d. ThyCurb, Inc.
 - e. Vent Products Co., Inc.

2.2 MATERIALS, GENERAL

- A. Aluminum Sheet: ASTM B 209 for alclad alloy 3005H25 or alloy and temper required to suit forming operations, with mill finish, unless otherwise indicated.
- B. Extruded Aluminum: ASTM B 221 alloy 6063-T52 or alloy and temper required to suit structural and finish requirements, with mill finish, unless otherwise indicated.
- C. Galvanized Steel Sheet: ASTM A 653/A 653M with G90 coating designation; commercial quality, unless otherwise indicated.
- D. Insulation: Manufacturer's standard rigid or semirigid glass-fiber board of thickness indicated, not less than 1 ½".
- E. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, complying with AWPA C2; not less than 1-1/2 inches thick.
- F. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by manufacturer. Match finish of exposed fasteners with finish of material being fastened.

2.3 ROOF CURBS

- A. General: Provide insulated roof curbs capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs.
- B. Fabrication: Unless otherwise indicated or required for strength, fabricate units from minimum 0.0747-inch- thick, structural-quality, hot-dip galvanized or aluminum-zinc alloy-coated steel sheet; factory primed and prepared for painting with welded or sealed mechanical corner joints.
 - 1. Provide preservative-treated wood nailers at tops of curbs and formed flange at perimeter bottom for mounting to roof.
 - 2. Provide manufacturer's standard rigid or semirigid insulation where indicated.
 - 3. Provide formed cants and base profile coordinated with roof insulation thickness.
 - 4. Fabricate units to minimum height of 12 inches, unless otherwise indicated.
 - 5. Sloping Roofs: Fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.
 - 6. Insulate curb with 1 ½" thick insulation to provide a continuous thermal envelope.

2.4 ROOF FLASHING

- A. General: Provide and coordinate flashing for all roof penetrations. Flashing shall be coordinated and compatible with the roofing system.

2.5 EQUIPMENT SUPPORTS

- A. General: Provide equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported.
- B. Fabrication: Unless otherwise indicated or required for strength, fabricate units from structural-quality, hot-dip galvanized or aluminum-zinc alloy-coated steel sheet; factory primed and prepared for painting with welded or sealed mechanical corner joints. Provide preservative-treated wood nailers at tops of curbs and formed flange at perimeter bottom for mounting to roof. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile. Fabricate units to minimum height of 12 inches above the finished roof, unless otherwise indicated. Fabricate support units with height tapered to match slope to level tops of units.
- C. Provide 3000 psi concrete reinforced with 6x6x6 WWF, housekeeping pads for all slab mounted equipment. Chamfer pad edges 1/2".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with manufacturer's written instructions. Coordinate installation of roof accessories with installation of roof deck, roof insulation, flashing, roofing membranes, penetrations, equipment, and other construction involving roof accessories to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight. Anchor roof accessories securely to supporting structural substrates so they are capable of withstanding lateral and thermal stresses, and inward and outward loading pressures.
- B. Cap Flashing: Where required as component of accessory, install cap flashing to provide waterproof overlap with roofing or roof flashing (as counterflashing). Seal overlap with thick bead of mastic sealant.

3.2 CLEANING AND PROTECTION

- A. Clean exposed surfaces according to manufacturer's written instructions. Touch up damaged metal coatings.

END OF SECTION 220506

SECTION 220510 – PIPE TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Pressure testing of piping systems.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PIPE TESTING

- A. Test all piping as specified herein. Test results shall demonstrate no leaks or appreciable loss of pressure. Repair or replace defective piping until tests are accomplished successfully.
- B. All nitrogen used for testing shall be oil-free dry nitrogen.
- C. All air used for testing shall be clean, dry, and oil-free.
- D. All piping systems shall be cleaned after testing
- E. Gas piping system shall be tested with air or nitrogen at 1 1/2" times proposed maximum working pressure but not less than 50 psig. Test duration will be 4 hour minimum. The system will withstand the test pressure with no evidence of leakage. Any reduction of test pressure as indicated by pressure gauge shall be deemed to indicate the presence of a leak. The leakage shall be located by means of soap and water, or an approved equivalent nonflammable solution as applicable. Reference NFPA 54 for further details on gas pipe testing.

F.	System	Pressure	Medium	Duration
	Hot & Cold water (domestic)	150 psig	water	4 hours
	Natural gas	50 psig	air	8 hours
	Fire protection	200 psig	water	2 hours
	Waste & vent	10 feet	water	4 hours

END OF SECTION 220510

SECTION 220513 - COMMON MOTOR AND CONTROLLER REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 SUBMITTALS

- A. Product Data for Field-Installed Motors: For each type and size of motor, provide nameplate data and ratings; shipping, installed, and operating weights; mounting arrangements; size, type, and location of winding terminations; conduit entry and ground lug locations; and information on coatings or finishes.
- B. Operation and Maintenance Data: For field-installed motors to include in emergency, operation, and maintenance manuals.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:
 - 1. Compatible with the following:
 - a. Magnetic controllers.
 - b. Multispeed controllers.
 - c. Reduced-voltage controllers.
 - 2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
 - 3. Matched to torque and horsepower requirements of the load.
 - 4. Matched to ratings and characteristics of supply circuit and required control sequence.

PART 2 - PRODUCTS

2.1 MOTOR REQUIREMENTS

- A. Motor requirements apply to factory-installed and field-installed motors except as follows:
 - 1. Different ratings, performance, or characteristics for a motor are specified in another Section.

2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

2.2 MOTOR CHARACTERISTICS

- A. Motors 1/2 HP and Larger: Three phase.
- B. Motors Smaller Than 1/2 HP: Single phase.
- C. Frequency Rating: 60 Hz.
- D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
- E. Service Factor: 1.15 for open drip proof motors; 1.0 for totally enclosed motors.
- F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
- G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- H. Enclosure: Open drip proof for general use, weatherproof, explosion proof, etc., as required for special duty application.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Comply with requirements of the NCSBC and EPACT and NEMA Table 12.6C, but at a minimum meet or exceed value listed in following table.

Minimum Full Load Efficiency				Minimum Full Load Efficiency			
Open Motors				Enclosed Motors			
Rating HP	3600 RPM 2-POLE	1800 RPM 4-POLE	1200 RPM 6-POLE	Rating HP	3600 RPM 2-POLE	1800 RPM 4-POLE	1200 RPM 6-POLE
1		82.5	80.0	1	75.5	82.5	80.0
1.5	82.5	84.0	84.0	1.5	82.5	84.0	85.5

2	84.0	84.0	85.5	2	84.0	84.0	86.5
3	84.0	86.5	86.5	3	85.5	87.5	87.5
5	85.5	87.5	87.5	5	87.5	87.5	87.5
7.5	87.5	88.5	88.5	7.5	88.5	89.5	89.5
10	88.5	89.5	90.2	10	89.5	89.5	89.5
15	89.5	91.0	90.2	15	90.2	91.0	90.2
20	90.2	91.0	91.0	20	90.2	91.0	90.2
25	91.0	91.7	91.7	25	91.0	92.4	91.7
30	91.0	92.4	92.4	30	91.0	92.4	91.7
40	91.7	93.0	93.0	40	91.7	93.0	93.0
50	92.4	93.0	93.0	50	92.4	93.0	93.0
60	93.0	93.6	93.6	60	93.0	93.6	93.6
75	93.0	94.1	93.6	75	93.0	94.1	93.6
100	93.0	94.1	94.1	100	93.6	94.5	94.1
125	93.6	94.5	94.1	125	94.5	94.5	94.1
150	93.6	95.0	94.5	150	94.5	95.0	95.0
200	94.5	95.0	94.5	200	95.0	95.0	95.0

- C. Stator: Copper windings, unless otherwise indicated.
- D. Rotor: Squirrel cage, unless otherwise indicated.
- E. Bearings: Double-shielded, ball bearings suitable for radial and thrust loading.
- F. Temperature Rise: Match insulation rating, unless otherwise indicated.

- G. Insulation: Class F, unless otherwise indicated.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Designed with critical vibration frequencies outside operating range of controller output.
 - 2. Temperature Rise: Matched to rating for Class B insulation.
 - 3. Insulation: Class H.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

- A. Type: One of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
- B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.
- C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, sleeve type for other single-phase motors.

2.6 CONTROLLERS AND CONTROLS:

- A. Controllers shall conform to adopted standards and recommended practices of the Industrial Control Standards of the National Electrical Manufacturers Association and the standard for Industrial Control Equipment of the Underwriters Laboratories, Inc. Single phase motors shall be provided with integral overload protection.
- B. Two (2) speed, three phase motors shall be one winding consequent pole type.
- C. Magnetic starters for motors 50 hp and smaller shall be full voltage, across the line type with undervoltage release for manual or automatic operation and shall break all phases on 3 phase starters.
- D. Starters for motors 60 hp and above shall be reduced voltage type. Starters shall be provided with start-stop pushbuttons mounted on cover unless controlled by hand-off-

automatic device. Hand-off-automatic device shall not be wired to override safety device interlocks on starter mounted on or adjacent to starter except where indicated on plans. If selector is mounted remotely, provide test start pushbutton on starter. All auxiliary contacts required for interlocking purposes shall be furnished and installed with starter. All manual motor starters shall be quick-make, quick-break, toggle action types with one-piece melting alloy type thermal units and pilot light.

- E. Starters shall be provided with proper size thermal elements which shall be of one-piece, interchangeable construction. The starter shall not operate with any element removed. All starters installed outdoors shall be provided with ambient temperature compensating motor overload devices. All starter enclosures shall be NEMA 1, indoors and NEMA 3R in exterior areas, unless noted otherwise.
- F. All starters and pushbutton stations shall be provided with labels as specified under identification designating service for which starter is used. Plate shall be firmly attached to starter or wall mounted adjacent to starter.
- G. Provide thermal element selection chart on the inside of each starter door.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
 - 2. Test interlocks and control features for proper operation.
 - 3. Verify that current in each phase is within nameplate rating.

3.2 ADJUSTING

- A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.3 CLEANING

- A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean motors, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 220513

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product certificates.
- C. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Thermometers:
 - a. Weksler Instruments Operating Unit.
 - b. Ernst Gage Co.
 - c. Palmer Instruments, Inc.
 - d. H. O. Trerice Co.
 - e. Weiss Instruments, Inc.
 - f. Ashcroft Commercial Sales Operation.
 2. Pressure Gages:
 - a. Ashcroft Commercial Sales Operation.
 - b. Weksler Instruments Operating Unit.
 - c. Ernst Gage Co.
 - d. Marsh Bellofram.
 - e. Trerice: H. O. Trerice Co.
 - f. Weiss Instruments, Inc.

2.2 THERMOMETERS, GENERAL

- A. Scale Range: Temperature ranges for services listed are as follows:
 - 1. Domestic Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
 - 2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.
 - 3. Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
- B. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.
- C. Use digital type thermometers.

2.3 DIGITAL THERMOMETERS

- A. Description: Variable angle, light powered, digital thermometer.
- B. Case: High impact ABS.
- C. Display: 3/8" LCD digits, wide ambient formula.
- D. Lux rating: 10 lux (1 foot candle)
- E. Update: 10 seconds
- F. Ambient operating temperature: -30°F to 140°F
- G. Sensor: Glass passivated thermistor
- H. Stem assembly: Industrial glass type
- I. Fahrenheit to Celsius switchable
- J. Weiss Vari-angle Digital thermometer or equal

2.4 SEPARABLE SOCKETS

- A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.
 - 1. Material: Brass, for use in copper piping.
 - 2. Material: Stainless steel, for use in steel piping.
 - 3. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.
 - 4. Insertion Length: To extend to one-third of diameter of pipe.
 - 5. Cap: Threaded, with chain permanently fastened to socket.
 - 6. Heat-Transfer Fluid: Oil or graphite.

2.5 THERMOMETER WELLS

- A. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.
 - 1. Material: Brass, for use in copper piping.
 - 2. Material: Stainless steel, for use in steel piping.

3. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.
4. Insertion Length: To extend to one-third of diameter of pipe.
5. Cap: Threaded, with chain permanently fastened to socket.
6. Heat-Transfer Fluid: Oil or graphite.

2.6 PRESSURE GAGES

- A. Description: ASME B40.1, phosphor-bronze bourdon-tube type with bottom connection; dry type, unless liquid-filled-case type is indicated.
- B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch- diameter, glass lens.
- C. Connector: Brass, NPS 1/4.
- D. Scale: White-coated aluminum with permanently etched markings.
- E. Accuracy: Grade A, plus or minus 1 percent of middle 50 percent of scale.
- F. Range: Comply with the following:
 1. Vacuum: 30 inches Hg of vacuum to 15 psig of pressure.
 2. Fluids under Pressure: Two times the operating pressure.

2.7 PRESSURE-GAGE FITTINGS

- A. Valves: NPS 1/4 copper or bronze ball valve.
- B. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
- C. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

PART 3 - EXECUTION

3.1 METER AND GAGE INSTALLATION, GENERAL

- A. Install meters, gages, and accessories according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

- A. Install digital thermometers and adjust vertical and tilted positions.
- B. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.

1. Install with socket extending a minimum of 2 inches into fluid.
 2. Install with socket extending to one-third of diameter of pipe.
 3. Install with socket extending to center of pipe.
 4. Fill sockets with oil or graphite and secure caps.
- C. Install thermometer wells in vertical position in piping tees where test thermometers are indicated.
1. Install with stem extending a minimum of 2 inches into fluid.
 2. Install with stem extending to one-third of diameter of pipe.
 3. Install with stem extending to center of pipe.
 4. Fill wells with oil or graphite and secure caps.

3.3 PRESSURE-GAGE INSTALLATION

- A. Install pressure gages in piping tees with pressure-gage valve located on pipe at most readable position.
- B. Install liquid-filled-type pressure gages at suction and discharge of each pump.
- C. Install pressure-gage needle valve and snubber in piping to pressure gages.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:
1. Install meters and gages adjacent to machines and equipment to allow service and maintenance.
 2. Connect flow-measuring-system elements to meters.
 3. Connect flowmeter transmitters to meters.
 4. Connect thermal-energy-flowmeter transmitters to meters.
- B. Make electrical connections to power supply and electrically operated meters and devices.
- C. Ground electrically operated meters.

3.5 ADJUSTING AND CLEANING

- A. Calibrate meters according to manufacturer's written instructions, after installation.
- B. Adjust faces of meters and gages to proper angle for best visibility.
- C. Clean windows of meters and gages and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Bronze gate valves.
7. Iron gate valves.
8. Bronze globe valves.
9. Iron globe valves.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.2 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.3 QUALITY ASSURANCE

- A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
- B. NSF Compliance: NSF 61 for valve materials for potable-water service.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.

- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures, 200 psi CWP minimum.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
 - 4. Wrench: For plug valves with square heads.
 - 5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Gate Valves: With rising stem.
 - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Solder Joint: With sockets according to ASME B16.18.
 - 3. Threaded: With threads according to ASME B1.20.1.
 - 4. Bronze Valves: NPS 2 and smaller with threaded or solder ends, unless otherwise indicated.
 - 5. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Red-White Valve Corporation.
 - g. Conbraco Industries, Inc.; Apollo Valves.
 - h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2.3 BALL VALVES

- A. MSS SP-110, Class 150 Ball Valves, 1/2-Inch to 4-Inch: Rated for 150 psi saturated steam pressure, 400 psi WOG pressure; 2-piece construction; with bronze body conforming to ASTM B 62, standard or conventional port, chrome-plated brass ball, replaceable "Teflon" or "TFE" seats and seals, blowout proof stem, extended stem for insulated systems, and vinyl-covered steel handle.

2.4 BUTTERFLY VALVES

- A. MSS SP-67, Type I, rated bubbletight at 200 psi for tight shutoff, with disc and lining suitable for potable water, unless otherwise indicated. Butterfly valves shall have ductile or cast iron body, bronze floating type disc, EPT seat, 416 stainless steel dry journal type stems, bronze bearings. Bodies shall be full lug type with extended necks adequate for the appropriate insulation thickness. Operators shall be 10 position positive lock lever type in sizes 4" to 6", and worm gear operators for 8" and above

2.5 GATE VALVES

- A. Gate Valves, 2-Inch and Smaller: MSS SP-80; Class 150, body and union bonnet of ASTM B 62 cast bronze; with threaded ends or solder ends, solid disc, copper-silicon alloy stem, brass packing gland, "Teflon" impregnated packing, and malleable iron handwheel.
- B. Gate Valves, 2-1/2-Inch and Larger: MSS SP-70; Class 125 iron body, bronze mounted, with body and bonnet conforming to ASTM A 126 Class B; outside screw and yoke, with flanged ends, "Teflon" impregnated packing, and two-piece backing gland assembly.

2.6 GLOBE VALVES

- A. Globe Valves, 2-inch and Smaller MSS SP-80; Class 125; body and screwed bonnet of ASTM B62 cast bronze; with threaded or solder ends, brass of replaceable composition disc, copper-silicon alloy stem, brass packing gland, "Teflon" impregnated packing, and malleable iron handwheel. Provide Class 150 valves meeting the above where system pressure requires.
- B. Globe Valves 2-1/2 inch and Larger MSS SP-85; Class 125 iron body and bolted bonnet conforming to ASTM A 126, Class B; with outside screw and yoke, bronze mounted, flanged ends, and "Teflon" impregnated packing, and two-piece packing gland assembly.

2.7 CHECK VALVES

- A. Swing Check Valves, 2-Inch and Smaller MSS SP-80; Class 125, cast-bronze body and cap conforming to ASTM B 62; with horizontal swing, Y-pattern, and bronze disc; and having threaded or solder ends. Provide Class 150 valves meeting the above specifications, with threaded end connections, where system pressure requires or where Class 125 is not available.
- B. Swing Check Valves, 2-1/2 Inch and Larger MSS SP-71; Class 125, cast iron body and bolted cap conforming to ASTM A 126, Class B; horizontal swing, and bronze disc or cast-iron disc with bronze disc ring; and flanged ends.

- C. Wafer Check Valves Class 125, 200 psi WOG, cast-iron body with replaceable bronze seat, and non-slam design lapped and balanced twin bronze flappers and stainless steel trim and torsion spring. Provide valves designed to open and close at approximately one foot differential pressure.

2.8 BALANCING VALVES (CIRCUIT SETTER)

- A. Calibrated Balancing Valves, NPS 2 and Smaller: Bronze body, brass ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having threaded or soldered ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position. Valve shall be rated for shutoff service.
- B. Calibrated Balancing Valves, NPS 2-1/2 and Larger: Cast-iron or steel body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having flanged or grooved connections. Valves shall have calibrated orifice or venturi; connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position. Valve shall be rated for shutoff service.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.

3.2 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly, or gate valves.
 - 2. Throttling Service: Globe or ball valves.
 - 3. Balancing Service: Circuit setter.
 - 4. Pump Discharge: Spring-loaded, lift-disc or wafer check valves.

3.4 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125, bronze disc.
3. Ball Valves: Two piece, regular port, brass or bronze with bronze trim.
4. Bronze Swing Check Valves: Class 125, bronze disc.
5. Bronze Gate Valves: Class 125, RS.
6. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: flanged ends
2. Iron Swing Check Valves: Class 125, metal seats.
3. Iron Gate Valves: Class 125, OS&Y.
4. Iron Globe Valves: Class 125.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Fastener systems.
 - 5. Equipment supports.

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Powder-actuated fastener systems.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

1.6 FINISHES

- A. All hangers, supports, fasteners, etc. for outdoor installation shall be hot dip galvanized, indoor hangers shall be painted or galvanized. All hanger rod shall be hot dip galvanized or cadmium plated.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- C. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- D. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Design Mix: 5000-psi, 28-day compressive strength.

2.7 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
- B. All bracket, clamp and rod sizes indicated are minimum sizes only. The installing trade shall be responsible for structural integrity of all supports. All structural hanging materials shall have a safety factor of 5 built in and shall comply with MSS Standard SP-69.
- C. All hangers, supports, fasteners, etc. for outdoor installation shall be hot dip galvanized, indoor hangers shall be painted or galvanized. All hanger rod shall be hot dip galvanized or cadmium plated.
- D. Supports for uncovered copper tubing shall be especially designed for copper tubing, shall be of exact outside diameter of tubing and shall be copper plated.
- E. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
 - 1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
 - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

2.8 MISCELLANEOUS MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
 - 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 - 2. Properties: Nonstaining, noncorrosive, and nongaseous.

3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections. Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

Description	Type
Insulation Protection Shield	40
Pipe saddle	39
Clevis hanger	1
Roller hanger	43
Clevis	14
Eye Nut	17
Eye Socket	16
U-bolt	24
Copper Tubing Hanger	10
Beam Clamp	23
Pipe Roller Stand	44 and 46
Pipe Clamp	4 and 3
Riser Clamp	8
Center Load Beam Clamp	21
Wall Bracket	32 and 33
Welded Beam Attachment	22
Concrete Insert	18
Turnbuckle	13

- C. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

- B. Supports, anchors, hangers and guides per MSS SP-69 shall be provided for all horizontal and vertical piping. Hangers shall be so arranged as to prevent excessive deflection and avoid excessive bending stresses.
- C. Clevis type hangers shall be used for support of "cold" or ambient temperature piping systems, provide galvanized insulation shields with flared ends for insulated piping.
- D. Roller type supports shall be used for hot pipes subject to axial movement.
- E. Supports shall be braced so that movement occurs in roller rather than support rods. Provide beam clamps, turnbuckles, struts, channels, angle iron, and miscellaneous supports as required for a complete installation.
- F. Pipe hangers shall be installed no further than 24" from any change of direction.
- G. Contractor shall bear all responsibility for materials and workmanship as described in this section and shall make sure that all hangers and supports are properly and permanently connected to building structure.
- H. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.4 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- C. All hangers, supports, fasteners, etc. for outdoor installation shall be hot dip galvanized, indoor hangers shall be painted or galvanized. All hanger rod shall be hot dip galvanized or cadmium plated.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.

1.2 SUBMITTAL

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 4. Fasteners: Stainless-steel rivets or self-tapping screws.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Yellow.
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- F. Fasteners: Stainless-steel rivets or self-tapping screws.
- G. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
- B. Pipe Label Color Schedule:
 - 1. Domestic Water Piping:
 - a. Background Color: Green
 - b. Letter Color: White
 - 2. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.

END OF SECTION 220553

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Flexible elastomeric.
 - b. Mineral fiber.
2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Sealants.
6. Factory-applied jackets.
7. Field-applied fabric-reinforcing mesh.
8. Field-applied jackets.
9. Tapes.
10. Securements.
11. Corner angles.

1.2 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.3 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
 - 1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
 - 2. Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
 - 3. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
 - a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
 - b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
 - 4. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
 - 5. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
 - 6. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
 - 7. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
 - 8. Products: Subject to compliance with requirements, provide one of the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000 Pipe Insulation.
 - d. Owens Corning; Fiberglas Pipe Insulation.
- B. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to

ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. CertainTeed Corp.; CrimpWrap.
- b. Johns Manville; MicroFlex.
- c. Knauf Insulation; Pipe and Tank Insulation.
- d. Owens Corning; Fiberglas Pipe and Tank Insulation.

C. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. **Polyethylene or Polymer insulations are not acceptable.** Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials. Insulation shall be AP/Armaflex or equal.

1. Adhesive: As recommended by insulation material manufacturer.
2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.
3. Products: Subject to compliance with requirements, provide one of the following:

- a. Aeroflex USA Inc.; Aerocel.
- b. Armacell LLC; AP Armaflex.
- c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

D. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.2 FIELD-APPLIED JACKETS

A. General: ASTM C 921, Type 1, unless otherwise indicated.

B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.

C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.

1. Adhesive: As recommended by insulation material manufacturer.
2. PVC Jacket Color: Color-code piping jackets based on materials contained within the piping system.

D. Heavy PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 30-mil-thick, high-impact, ultraviolet-resistant PVC.

1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
2. Adhesive: As recommended by insulation material manufacturer.

E. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-thick, high-impact, ultraviolet-resistant PVC.

1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 2. Adhesive: As recommended by insulation material manufacturer.
- F. Aluminum Jacket: Aluminum roll stock, ready for shop or field cutting and forming to indicated sizes. Comply with ASTM B 209, 3003 alloy, H-14 temper.
1. Finish and Thickness: Stucco-embossed finish, 0.016 inch thick.
 2. Moisture Barrier: 1-mil- thick, heat-bonded polyethylene and kraft paper.
 3. Elbows: Preformed, 45- and 90-degree, short- and long-radius elbows; same material, finish, and thickness as jacket.

2.3 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd..
1. Tape Width: 4 inches.
- B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
 2. Galvanized Steel: 0.005 inch thick.
 3. Aluminum: 0.007 inch thick.
 4. Brass: 0.010 inch thick.
 5. Nickel-Copper Alloy: 0.005 inch thick.
- C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

2.4 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply multiple layers of insulation with longitudinal and end seams staggered.
- F. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- H. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- I. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
 - 1. Apply insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
 - 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- J. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- K. Apply adhesives and mastics at the manufacturer's recommended coverage rate.

- L. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Circumferential Joints: Cover with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
 - 3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
 - 4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
 - 5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
 - M. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
 - 1. Seal penetrations with vapor-retarder mastic.
 - 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 - 3. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal metal jacket to roof flashing with vapor-retarder mastic.
 - N. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.
 - O. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
 - P. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."
 - Q. Floor Penetrations: Apply insulation continuously through floor assembly.
 - 1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.
- 3.4 MINERAL-FIBER INSULATION APPLICATION
- A. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
 2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.
 3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to flanges as follows:
1. Apply preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.
- C. Apply insulation to fittings and elbows as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
 3. Cover fittings with standard PVC fitting covers.
 4. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
- D. Apply insulation to valves and specialties as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
 3. Apply insulation to flanges as specified for flange insulation application.
 4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 5. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

6. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
 1. Follow manufacturer's written instructions for applying insulation.
 2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- B. Apply insulation to flanges as follows:
 1. Apply pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- C. Apply insulation to fittings and elbows as follows:
 1. Apply mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- D. Apply insulation to valves and specialties as follows:
 1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
 2. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to stainer basket.
 3. Apply insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.6 FIELD-APPLIED JACKET APPLICATION

- A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.

1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of jacket manufacturer's recommended adhesive.
3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

B. Foil and Paper Jackets: Apply foil and paper jackets where indicated.

1. Draw jacket material smooth and tight.
2. Apply lap or joint strips with the same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Apply jackets with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.

C. Apply PVC jacket where indicated, with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

D. Apply metal jacket where indicated, with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 FINISHES

- A. Glass-Cloth Jacketed Insulation: Paint insulation exposed to view finished with glass-cloth jacket as specified in Division 9 Section "Painting."
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.
- C. Color: Color code per ANSI or owners standard color scheme. Final color as selected by Engineer. Vary first and second coats to allow visual inspection of the completed Work.

3.8 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
1. Flexible connectors.
 2. Vibration-control devices.
 3. Fire-suppression piping.
 4. Drainage piping located in crawl spaces, unless otherwise indicated.
 5. Below-grade piping, unless otherwise indicated.
 6. Chrome-plated pipes and fittings, unless potential for personnel injury.

7. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.9 FIELD QUALITY CONTROL

- A. Inspection: Inspect fittings and valves randomly selected by Engineer.
- B. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.
- C. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.10 INSULATION APPLICATION SCHEDULE, GENERAL

- A. Materials and thicknesses for systems listed below shall comply with the requirements of the North Carolina State Energy Code and shall be not less than the thicknesses specified below.

3.11 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Domestic hot and recirculated hot water.
 1. Operating Temperature: 100 to 139 deg F.
 2. Insulation Material: **Mineral fiber**
 3. Insulation Thickness: Apply the following insulation thicknesses:

Runouts less than 12' long up to and including 1".....	1/2"
Pipe size up to 1 1/4"	1/2"
Pipe size over 1 1/4"	1"
 4. Field-Applied Jacket: **PVC for exposed areas, Foil and Paper (ASJ) concealed areas.**
 5. Vapor Retarder Required: No
- B. Service: Domestic cold water.
 1. Operating Temperature: 45 to 80 deg F.
 2. Insulation Material: **Mineral fiber**
 3. Insulation Thickness:

Pipe size 1" I.P.S. and below.....	1/2"
Pipe size 1 1/4" to 2"	1"
Pipe size 2 1/2" to 6"	1"
 4. Field-Applied Jacket: **PVC for exposed areas, Foil and Paper (ASJ) concealed areas.**
 5. Vapor Retarder Required: Yes
- C. Service: Horizontal Sanitary Waste P-Traps and Piping from HVAC Air-handling units.
 1. Operating Temperature: 32 to 100 deg F.
 2. Insulation Material: **Mineral fiber**

3. Insulation Thickness: 1"
 4. Field-Applied Jacket: **PVC for exposed areas, Foil and Paper (ASJ) concealed areas.**
 5. Vapor Retarder Required: **Yes**
- D. Service: Horizontal and Vertical Sanitary Waste Piping exposed to outside of the building.
1. Operating Temperature: 32 to 100 deg F.
 2. Insulation Material: **Mineral fiber**
 3. Insulation Thickness: 1"
 4. Field-Applied Jacket: **PVC for exposed areas, Foil and Paper (ASJ) concealed areas.**
 5. Vapor Retarder Required: **Yes**
- E. Service: Horizontal Roof Drain Leaders and Rainwater Conductors.
1. Operating Temperature: 32 to 100 deg F.
 2. Insulation Material: **Mineral fiber**
 3. Insulation Thickness: 1"
 4. Field-Applied Jacket: **PVC for exposed areas, Foil and Paper (ASJ) concealed areas.**
 5. Vapor Retarder Required: **Yes**
- F. Service: Roof Drain bodies.
1. Operating Temperature: 32 to 100 deg F.
 2. Insulation Material: **Mineral fiber**
 3. Insulation Thickness: 1"
 4. Field-Applied Jacket: **PVC for exposed areas, Foil and Paper (ASJ) concealed areas.**
 5. Vapor Retarder Required: **Yes**
- G. Service: Exposed sanitary drains and domestic water supplies and stops for fixtures for the disabled.
1. Operating Temperature: 35 to 120 deg F.
 2. Insulation Material: **Mineral fiber.**
 3. Insulation Thickness: 1"
 4. Field-Applied Jacket: **PVC P-trap and supply covers.**
 5. Vapor Retarder Required: **Yes**
- 3.12 EXTERIOR INSULATION APPLICATION SCHEDULE
- A. This application schedule is for aboveground insulation outside the building.
1. Piping shall be insulated same as interior piping plus with an aluminum weatherproof jacket.

END OF SECTION 220700

SECTION 22 11 13 - FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes water-distribution piping and related components outside the building for water service.
- B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.
- C. All materials and installations must meet the requirements of the City of Durham, Durham City/County Inspections, North Carolina State Building Code, and NCDENR, as required.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components. Provide shop drawings for all piping, piping components, valves, hydrants, and backflow prevention devices.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
 - 2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
 - 3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
- D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

- E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- F. NSF Compliance:
 - 1. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
 - 2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.4 PROJECT CONDITIONS

- A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
 - 1. Notify Architect and Owner no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of water-distribution service without Architect's or Owner's written permission.

1.5 COORDINATION

- A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. All water pipe will meet the requirements of the City of Durham Standard Specifications for Water and Sewer Construction.
- B. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
 - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- C. Hard Copper Tube: ASTM B 88, Type K, water tube, drawn temper.
 - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

- D. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- E. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Gaskets: AWWA C111, rubber.

2.2 JOINING MATERIALS

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for commonly used joining materials.
- B. Brazing Filler Metals: AWS A5.8, BCuP Series.
- C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.
- D. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.3 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Tubular-Sleeve Pipe Couplings:
 - 1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
 - a. Standard: AWWA C219.

2.4 GATE VALVES

- A. AWWA, Cast-Iron Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the approved manufacturers in the City of Durham Standard Specifications for

Water and Sewer. All valves will meet the requirements of the City of Durham Standard Specifications for Water and Sewer Construction

2. Nonrising-Stem, Resilient-Seated Gate Valves:
 - a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 200 psig.
 - 3) End Connections: Mechanical joint.
 - 4) Interior Coating: Complying with AWWA C550.
3. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:
 - a. Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 250 psig.
 - 3) End Connections: Push on or mechanical joint.
 - 4) Interior Coating: Complying with AWWA C550.
4. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:
 - a. Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 200 psig.
 - 3) End Connections: Flanged.

2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Tapping-Sleeve Assemblies:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the approved manufacturers for gate valves in the City of Durham Standard Specifications for Water and Sewer. Product will meet the requirements of the City of Durham Standard Specifications for Water and Sewer Construction
 2. Description: Sleeve and valve compatible with drilling machine.
 - a. Standard: MSS SP-60.
 - b. Tapping Sleeve: Ductile-iron , two-piece bolted sleeve with flanged outlet for new branch connection, conforming to all applicable AWWA specifications. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
 - c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

- B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter. Product will meet the requirements of the City of Durham Standard Specifications for Water and Sewer Construction
 - 1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
- C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.6 CORPORATION VALVES

- A. Manufacturers:
 - 1. Product will meet the requirements of the City of Durham Standard Specifications for Water and Sewer Construction.
- B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.
 - 1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
 - 2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
 - 3. Product will meet the requirements of the City of Durham Standard Specifications for Water and Sewer Construction

2.7 WATER METERS

- A. Water meters will be provided by the City of Durham. The Owner will be responsible for paying the meter fee and capital facility fees for the meter to the City of Durham.

2.8 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers approved by the City of Durham.
 - 2. Requirements: Devices will meet all requirements of City of Durham Cross Connection Control.
 - 3. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
 - 4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 - 5. Strainer: Provide wye strainer as part of assembly.

6. Flow detector: Provide flow detector assembly as required.
 7. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
- B. Double-Check, Backflow-Prevention Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers approved by the City of Durham
 2. Requirements: Devices will meet all requirements of City of Durham Cross Connection Control.
 3. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
 4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 5. Strainer: Provide wye strainer as part of assembly.
 6. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

2.9 WATER METER BOXES

- A. Water meter boxes and vaults will meet the requirements of the City of Durham Standards.

2.10 CONCRETE VAULTS

1. Description: Precast, reinforced-concrete vault, meeting all requirements of City of Durham Standard Specifications

2.11 FIRE HYDRANTS

- A. Dry-Barrel Fire Hydrants: Meet all requirements of the City of Durham Standard Specifications for Water and Sewer

2.12 IRRIGATION BOOSTER PUMP

- A. Basis of design for booster pump is Floboy pumping system. Model FBSNV4BF7G46F3ABEL. Provide this pump or equal.
- B. Booster pump will be sized to provide 25 PSI pressure increase at 180 GPM flow. Pump will be 480 volt, 3 phase.
- C. Pump system will include, but not be limited to, the following features:
1. Variable frequency drive

2. Industrial grade touch controller
3. ON/OFF/AUTO Selector switch
4. LOW/HIGH pressure shutdown and alarm
5. Low suction pressure switch
6. Red alarm light
7. 3" magnetic flow meter
8. Discharge isolation valve
9. Effector flow switch for flow start/stop
10. Pump will be configured to run when irrigation line is flowing and stop with flow stops

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. Underground water-service piping NPS 3/4 to NPS 3 shall be soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
- F. Underground water-service piping NPS 4 and larger shall be the following:
 1. Ductile-iron, push-on-joint pipe; ductile-iron, mechanical-joint fittings.
- G. Underground Fire-Service-Main Piping shall be any of the following:
 1. Ductile-iron, push-on-joint pipe; gasketed mechanical-joint pipe; ductile-iron, mechanical-joint fittings.

3.3 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG,

nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated gate valves with valve box.
 2. Underground Valves, NPS 4 and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
 3. Use the following for valves in vaults and aboveground:
 - a. Gate Valves, NPS 2 and Smaller: Bronze, rising stem.
 - b. Gate Valves, NPS 3 and Larger: AWWA, cast iron, OS&Y rising stem, resilient seated.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. See Division 22 Section "Common Work Results for Plumbing" for piping-system common requirements.

3.5 PIPING INSTALLATION

- A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.
- B. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.
- C. Make connections larger than NPS 2 with tapping machine according to the following:
1. Install tapping sleeve and tapping valve according to MSS SP-60.
 2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
 3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
 4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
- D. Make connections NPS 2 and smaller with drilling machine according to the following:
1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
 2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
 3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
 4. Install corporation valves into service-saddle assemblies.

5. Install manifold for multiple taps in water main.
 - E. Comply with NFPA 24 for fire-service-main piping materials and installation.
 1. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
 - F. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
 - G. Bury piping with depth of cover over top at least 36 inches.
 - H. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
 1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
 - I. Sleeves are specified in Division 22 Section "Common Work Results for Plumbing."
 - J. Mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
 - K. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- 3.6 JOINT CONSTRUCTION
- A. See Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.
 - B. Make pipe joints according to the following:
 1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
 2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
 3. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
 4. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
 5. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure. Refer to Division 22 Section "Common Work Results for Plumbing" for joining piping of dissimilar metals.

3.7 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 - 1. Concrete thrust blocks.
 - 2. Locking mechanical joints.
 - 3. Set-screw mechanical retainer glands.
 - 4. Bolted flanged joints.
 - 5. Heat-fused joints.
 - 6. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 - 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
 - 2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
 - 3. Fire-Service-Main Piping: According to NFPA 24.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- C. MSS Valves: Install as component of connected piping system.
- D. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

3.9 WATER METER INSTALLATION

- A. Install water meters, piping, and specialties according to City of Durham Standards.

3.10 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers according to City of Durham Standards

3.11 WATER METER BOX INSTALLATION

- A. Install water meter boxes in paved areas flush with surface.
- B. Install water meter boxes in grass or earth areas with top 1 inch above surface.

3.12 CONCRETE VAULT INSTALLATION

- A. Install precast concrete vaults according to ASTM C 891.

3.13 FIRE HYDRANT INSTALLATION

- A. General: Install fire hydrants in accordance with City of Durham Standards and Specifications.

3.14 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

- B. Hydrostatic Tests:

- 1. Test at not less than one-and-one-half times working pressure for two hours. The lines will be filled with water, and all air will be removed there from. A suitable pump will be connected, and the pressure in the pipe(s) raised to not less than 150 psi, measured at the highest point on the system installed or being tested. This pressure will be maintained for not less than three (3) hours, and any additional water required to maintain this pressure by an approved meter installed in the testing apparatus. The leakage for the three hour test period will not exceed that allowed by AWWA Standard C600, latest revision. If leakage exceeds this figure, the leak(s) will be located, repaired, and the testing repeated until the test is passed.

The amount of water in gallons per hour necessary to maintain the test pressure during the three-hour period will not exceed the amount calculated from the following formula:

$$L = \frac{(SD)(\text{sq. root } P)}{133,200}$$

where:

L = Leakage in G.P.H.

S = Length of line to be tested in feet

P = Average pressure in psi, at mid elevation maintained during test

D = Internal diameter of pipe in inches

Failure of the waterline to comply with the above acceptable leakage rate, will require the Contractor to replace any defective materials to insure a watertight installation. After any inadequacies have been corrected, the leakage rate will again be tested. This test will be repeated until that portion of the waterline has been brought into compliance with the permissible leakage rate.

After all pressure testing has been satisfactorily completed, the water will be discharged from the system to prevent contamination and wasted in such a manner so as not to cause any erosion on-site.

- C. Prepare reports of testing activities.

3.15 CLEANING

- A. Disinfection: Upon completion of pressure testing, all lines, including additions or replacements will be thoroughly flushed to remove any debris, stale water, etc... and will be chlorinated before being placed in service. All chlorination will take place under the witness of the Engineer or its representative. The City of Durham, Owner, and Architect will also be notified of the time and place of chlorination.

Any section of waterline piping that cannot be sterilized with multiple testing will be replaced as directed by the Engineer. Chlorination will only be performed after all waterlines have been satisfactorily installed and pressure tested.

Chlorination of all waterlines will be made at taps adjacent control valves at the upstream end of the waterline or at all extremities of the waterline, including valves. Taps will be located in such a manner to allow HTH solutions to be fed into all parts of the waterline.

Chlorination will be done by a solution of water containing high-test hypochlorite (70%) available chlorine or chlorine gas solution introduced into the waterline by regulated pumping at the tap. The solution injected into the waterlines will be of such a concentration that the waterline will have a uniform concentration of greater than 50 PPM total chlorine 24 hours after introducing the solution into the waterline.

Once the chlorine solution has been injected into the waterline, the solution will be circulated in the main through the use of opening / closing control valves and systematically flushing hydrants and taps at the extremities of the waterline. HTH solutions will be pumped into the waterlines at a constant rate for each discharge rate to produce a uniform concentration 50 PPM or better in the waterlines.

HTH solution will remain in the waterlines for no less than 24 hours. Extreme care will be exercised to prevent the HTH solution from entering / exiting waterlines.

Flushing will then be performed with a blow-off of sufficient size to clean the main and to remove the HTH solution from the waterlines until a DPD check shows that the waterlines contain a normal chlorine residual. A sample will then be taken and tested, and a determination made whether all bacteria has been removed and the chlorine residual is

acceptable. If so, the waterline may be placed into service; if not, chlorination and /or flushing will be repeated until tests are within the acceptable level. All waterlines will be disinfected according to AWWA Standard C651, latest revision and in accordance with the requirements of NCAC Title 15A Subchapter 18C Section 1003 Disinfection of Storage Tanks and Distribution Systems.

Listed below are minimum quantities of 70% HTH compound required in solution for each 1000-foot section of waterline in order to obtain the required 50 PPM concentration. Additional quantities may be required as necessary to obtain the 50 PPM at no additional cost to the Owner.

<u>Pipe Size</u>	<u>Pounds High Test Hypochlorite (70%) Per 1000 Feet of Line</u>
6"	0.88
8"	1.56
12"	3.50

- B. Prepare reports of purging and disinfecting activities. Coordinate all testing with the Engineer, City of Durham and Owner.
- C. Bacteriological Sampling: All water sample testing will be conducted at the City of Durham or a place so designated by the Owner. Before any waterline or portion thereof is considered disinfected and approved, two (2) consecutive negative samples at least 24 hours apart will be approved by the laboratory at the Water Treatment Plant or of the Owner's choosing.

Free residual chlorine after 24 hours will be at least 50 PPM. In the event that two successive bacteriologic tests fail, that section of the waterline will be rechlorinated by the Contractor and new tests performed at no expense to the Owner.

END OF SECTION 221113

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes domestic water piping from locations indicated to fixtures and equipment inside the building.
- B. Related Sections include the following:
 - 1. Division 22 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
 - 2. Division 22 Section "Plumbing Specialties" for water distribution piping specialties.

1.3 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- C. Transition Couplings for Underground Pressure Piping: AWWA C219, metal, sleeve-type coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 DUCTILE-IRON PIPING

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint, bell- and plain-spigot end, unless grooved or flanged ends are indicated.
 - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron, standard pattern; or AWWA C153, ductile-iron, compact pattern.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
 - 2. Ductile-Iron Piping, Grooved-End Fittings: ASTM A 47, malleable-iron castings or ASTM A 536 ductile-iron castings with dimensions matching pipe.
 - a. Ductile-Iron-Piping, Keyed Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint, bell- and plain-spigot end, unless grooved or flanged ends are indicated.
 - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron, standard pattern; or AWWA C153, ductile-iron, compact pattern.
 - a. Gaskets: AWWA C111, rubber.
 - 2. Ductile-Iron, Grooved-End Fittings: ASTM A 47, malleable-iron castings or ASTM A 536 ductile-iron castings with dimensions matching pipe.
 - a. Ductile-Iron-Piping, Keyed Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
 - 3. Ductile-Iron, Flexible Expansion Joints: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed, ball-joint sections and one or more gasketed, sleeve section. Assemble components for offset and expansion indicated. Include AWWA C111 ductile-iron glands, rubber gaskets, and steel bolts.
 - 4. Ductile-Iron, Deflection Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111 ductile-iron glands, rubber gaskets, and steel bolts.

2.3 COPPER TUBING

- A. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.
 - 1. Copper Pressure Fittings: ASME B16.22, wrought-copper, solder-joint fittings.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.

3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- B. Hard Copper Tube: ASTM B 88, Types L, water tube, drawn temper.
 1. Copper Pressure Fittings: ASME B16.22, wrought- copper, solder-joint fittings.
 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

2.4 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions:
 1. Description:
 - a. Pressure Rating: 150 psig at 180 deg F.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 1. Description:
 - a. Factory-fabricated, bolted, companion-flange assembly.
 - b. Pressure Rating: 175 psig minimum.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

2.5 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.
- C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.

2.6 SLEEVES

- A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

- C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

2.7 SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Stainless steel.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install domestic water piping level and plumb.
- D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- G. Install piping adjacent to equipment and specialties to allow service and maintenance.
- H. Install piping to permit valve servicing.
- I. Install piping free of sags and bends.

- J. Install fittings for changes in direction and branch connections.
- K. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

3.3 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
- B. Underground Domestic Water Service Piping: Use the following piping materials for each size range:
 - 1. NPS 2 ½" and Smaller: Soft copper tube, Type K; copper pressure fittings; and soldered joints.
 - 2. NPS 3" to NPS 8": Mechanical- or push-on-joint, ductile-iron pipe; mechanical- or push-on-joint, ductile-iron fittings; and restrained, gasketed joints.
- C. Aboveground Domestic Water Piping: Use the following piping materials for each size range:
 - 1. NPS 4" and Smaller: Hard copper tube, Type L; copper pressure fittings; and soldered joints.

3.4 JOINT CONSTRUCTION

- A. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Apply appropriate tape or thread compound to external pipe threads.
- B. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated solder shall be 95-5 for pipe sizes 1 ¼" and smaller. Pipe larger than 1 ¼": shall be brazed.
- D. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- E. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 22 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6: 12 feet with 3/4-inch rod.
- F. Install supports for vertical steel piping every 15 feet.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 6. NPS 6: 10 feet with 5/8-inch rod.
- H. Install supports for vertical copper tubing every 10 feet.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.
- 3.6 VALVE INSTALLATION
- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply

to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
 - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
 - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flows.

3.7 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.

3.8 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.9 ESCUTCHEON INSTALLATION

- A. Install escutcheons for exposed pipe penetrations of walls, ceilings, and floors.

3.10 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Install sleeves in new partitions, slabs, and walls as they are built.
- C. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
- D. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using **sleeve seals** specified in this Section.
- E. Seal space outside of sleeves in concrete slabs and walls with grout.
- F. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- G. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.
 - a. Extend sleeves 2 inches above finished floor level.
 - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 3. Sleeves for Piping Passing through Gypsum-Board Partitions:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
 - c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
 4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe.
 5. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Cast-iron wall pipe sleeves for pipes NPS 6 and larger.
 - c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
- H. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- 3.11 SLEEVE SEAL INSTALLATION
- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
 - B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- 3.12 IDENTIFICATION
- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- 3.13 FIELD QUALITY CONTROL
- A. Perform tests and inspections.
 - B. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
3. Cap and subject piping to static water pressure of 50 psig (125 psig minimum) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3.14 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated water mixing valves.
6. Strainers.
7. Hose bibbs.
8. Wall hydrants.
9. Drain valves.
10. Water hammer arresters.
11. Trap-seal primer valves.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cash Acme.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cash Acme.
 - b. Conbraco Industries, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Woodford Manufacturing Company.
 - e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1001.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.

2.2 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cash Acme.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Body: Bronze.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cash Acme.
 - b. Conbraco Industries, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.4 BALANCING VALVES

A. Memory-Stop Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Bell and Gossett
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lawler Manufacturing Company, Inc.
 - b. Leonard Valve Company.

- c. Powers; a Watts Industries Co.
 - d. Symmons Industries, Inc.
- 2. Standard: ASSE 1017.
- 3. Pressure Rating: 125 psig.
- 4. Type: Thermostatically controlled water mixing valve.
- 5. Material: Bronze body with corrosion-resistant interior components.
- 6. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
- 7. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
- 8. Valve Finish: Chrome plated.
- 9. Piping Finish: Chrome plated.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

- 1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
- 2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
- 3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
- 4. Screen: Stainless steel with round perforations, unless otherwise indicated.
- 5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.033 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch.
 - c. Strainers NPS 5 and Larger: 0.125 inch.
- 6. Drain: Hose-end drain valve.

2.7 HOSE BIBBS

A. Hose Bibbs:

- 1. Body Material: Bronze.
- 2. Seat: Bronze, replaceable.
- 3. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
- 4. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
- 5. Pressure Rating: 125 psig.
- 6. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
- 7. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
- 8. Finish for Finished Rooms: Chrome or nickel plated.
- 9. Include operating key with each operating-key hose bibb.
- 10. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.8 WALL HYDRANTS

A. Anti Freeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Woodford Manufacturing Company.
 - d. Zurn Plumbing Products Group; Light Commercial Operation.
 - e. Josam.
2. Standard: ASSE 1019, Type A or Type B.
3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
4. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
5. Pressure Rating: 125 psig.
6. Operation: Loose key.
7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 1/2 or NPS 3/4.
9. Outlet: With garden-hose thread complying with ASME B1.20.7.

2.9 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves Insert drawing designation if any:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.10 WATER HAMMER ARRESTERS

A. Water Hammer Arresters Insert drawing designation if any:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. PPP Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.

- e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASSE 1010 or PDI-WH 201.
 - 3. Type: Copper tube with piston.
 - 4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.11 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. PPP Inc.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
- 2. Standard: ASSE 1018.
- 3. Pressure Rating: 125 psig minimum.
- 4. Body: Bronze.
- 5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
- 6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
- 7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 - 3. Do not install bypass piping around backflow preventers.
- C. Install balancing valves in locations where they can easily be adjusted.
- D. Install water hammer arresters in water piping according to PDI-WH 201.

- E. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- F. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- G. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Intermediate atmospheric-vent backflow preventers.
 - 2. Reduced-pressure-principle backflow preventers.
 - 3. Double-check backflow-prevention assemblies.
 - 4. Water pressure-reducing valves.
 - 5. Primary, thermostatic, water mixing valves.
 - 6. Supply-type, trap-seal primer valves.
- H. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.2 FIELD QUALITY CONTROL

- A. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.3 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

SECTION 22 13 13 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes gravity-flow, nonpressure sanitary sewerage outside the building, with the following components:
 - 1. Cleanouts.
 - 2. Precast concrete manholes.
 - 3. Sewer laterals and mains

1.2 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow: PVC - Schedule 40, ductile iron – Class 50. Installation and materials will meet all requirement of City of Durham, Durham City/County Inspection Department, North Carolina Building Code, and NCDENR.

1.3 SUBMITTALS

- A. Shop Drawings: For manholes, pipe, and accessories. Include plans, elevations, sections, details, and frames and covers.
- B. Coordination Drawings: Show pipe sizes, locations, and elevations.
- C. Field quality-control test reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.
- B. All materials will meet the requirement of the City of Durham Standard Specifications for Water and Sewer.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.

- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

- A. Pipe: Minimum Class 50 pipe in accordance with ANSI A21.50. Pipe will conform to ANSI A21.51 and be tar coated. Linings will cover both bell and spigot. Joints will be push on or mechanical joint.
- B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153, for push-on joints.
- D. Gaskets: AWWA C111, rubber.
- E. All materials will meet the requirement of the City of Durham Standard Specifications for Water and Sewer

2.4 PVC PIPE AND FITTINGS

- A. PVC Sewer Pipe and Fittings, NPS 6 and Smaller: ASTM D 1784, Schedule 40 with solvent weld joints. Install solvent weld joints per manufacturer's recommendations. NPS 8 through NPS 15: ASTM D-3034 SDR 35, Type PSM sewer pipe and fittings with bell and spigot joints with rubber gaskets which conform to ASTM F 744.
- B. All materials will meet the requirement of the City of Durham Standard Specifications for Water and Sewer

2.5 MANHOLES

- A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints. Manholes will meet specifications of City of Durham. Manholes will be constructed of concrete that reaches a minimum strength of 4,000 PSI at 28 days.
 - 1. Diameter: 48 inches minimum, unless otherwise indicated.
 - 2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
 - 3. Base Section: 6-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
 - 4. Riser Sections: 5-inch minimum thickness, and of length to provide depth indicated.
 - 5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.

6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
8. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals.
9. Manhole Frames and Covers: Ferrous metal ring and cover meeting all requirements of City of Durham Standard Specification. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."

2.6 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
 1. Cement: ASTM C 150, Type II.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 1 percent through manhole, unless otherwise shown.
 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 4 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of 1 percent for NPS 6, 2 percent for NPS 4, unless otherwise indicated.
 - 2. Install piping below frost line.
 - 3. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 - 4. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
- F. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.2 PIPE JOINT CONSTRUCTION

- A. Basic piping joint construction is specified in Division 22 Section "Common Work Results for Plumbing." Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
- B. Join gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
3. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
4. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
5. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

3.3 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Form continuous concrete channels and benches between inlets and outlet.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 2 inches above finished surface elsewhere, unless otherwise indicated.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Install piping so cleanouts open in direction of flow in sewer pipe.
 1. Use light-duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
 2. Use heavy-duty, top-loading classification cleanouts in pavement areas.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 4 inches deep. Set with tops 1 inch above surrounding grade.
- C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.5 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."
- B. Make connections to existing piping and underground manholes.
 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

3.6 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate report for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
 - a. Allowable leakage is maximum of 100 gal./inch of nominal pipe size per mile of pipe, during 24-hour period.
 - b. Close openings in system and fill with water.
 - c. Purge air and refill with water.
 - d. Disconnect water supply.
 - e. Test and inspect joints for leaks.
 - f. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 psig.
 - 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
 - b. Option: Test concrete gravity sewer piping according to ASTM C 924.

- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
- E. Test manholes for leakage according to the requirements of the City of Durham and NCDENR.

END OF SECTION 221313

SECTION 221316 - SANITARY WASTE AND VENT AND ROOF DRAIN LEADER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes soil and waste, sanitary drainage and vent, roof drain leader and rainwater conductor piping inside the building and to locations indicated.
- B. Related Sections include the following:
 - 1. Division 22 Section "Plumbing Specialties" for soil, waste, and vent piping systems specialties.

1.3 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Flexible Transition Couplings for Underground Nonpressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.

2.2 CAST-IRON SOIL PIPING

- A. Hub-and-Spigot Pipe and Fittings: ASTM A 74, Service Weight class, coated for general duty.
 - 1. Gaskets: ASTM C 564, rubber.
- B. Hubless Pipe and Fittings: ASTM A 888 or CISPI 301, coated for general duty.
 - 1. Couplings: ASTM C 1540 assembly of metal housing, corrosion-resistant fasteners, and ASTM C 564 rubber sleeve with integral, center pipe stop.

- a. Heavy-Duty, Type 304, Stainless-Steel Couplings: ASTM C 1540, Type 304, stainless-steel shield; stainless-steel bands; and sleeve.

- 1) NPS 1-1/2 to NPS 4: 3-inch- wide shield with 4 bands.
- 2) NPS 5 to NPS 10: 4-inch- wide shield with 6 bands.

2.3 Solid core PVC DWV SOIL PIPING

- A. Solid core schedule 40 DWV Pipe and Fittings: ASTM F 1488,
- B. Solid core PVC pipe solvent cementing: Joints surfaces shall be clean and free from moisture. A purple primer that conforms to ASTM F 656 shall be applied. Solvent cement not of purple color and conforming to ASTM D 2564, CSA B137.3, CSA B181.2 or CSA B181.1 shall be applied to all joint surfaces. Solvent-cement joints shall be permitted above or below ground.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
- B. Aboveground, Soil, Waste, Vent, and roof drain leader Piping: Use the following piping materials for each size range:
 - 1. Hubless cast iron pipe , fittings and heavy duty couplings:
- C. Underground, Soil, Waste, Vent, Roof drain leader, and Rainwater Conductor Piping: Use the following piping materials for each size range:
 - 1. Schedule 40 DWV PVC solid core.

3.2 PIPING INSTALLATION

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping installation.
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for sleeves and mechanical sleeve seals.
- D. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures

are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

- E. Install soil and waste drainage and vent piping at the NCSBC minimum slopes, unless otherwise indicated:
- F. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- G. Roof Drain Leader, Waste and Vent piping in air plenums must be cast iron pipe and fittings.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 22 Section "Mechanical Vibration Controls and Seismic Restraints" for seismic-restraint devices.
- B. Refer to Division 22 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- C. Install supports according to Division 22 Section "Hangers and Supports."
- D. Support vertical piping and tubing at base and at each floor.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6: 60 inches with 3/4-inch rod.
 - 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
 - 6. NPS 15: 60 inches with 1-inch rod.
 - 7. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install supports for vertical steel piping every 15 feet.

- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.4 FIELD QUALITY CONTROL

- A. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

3.5 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:

1. Backwater valves.
2. Cleanouts.
3. Floor drains.
4. Roof flashing assemblies.
5. Miscellaneous sanitary drainage piping specialties.
6. Flashing materials.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

1.3 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

- A. Horizontal, Cast-Iron Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Body: Cast iron.
3. Cover: Cast iron with bolted or threaded access check valve.
4. Type Check Valve: Removable, bronze, swing check..

2.2 CLEANOUTS

A. Adjustable Cast-Iron Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Body Material: Cast iron
3. Closure: Gas and watertight ABS tapered thread plug
4. Adjustable Housing Material: Cast iron with threads.
5. Frame and Cover: Round polished scoriated nickel-bronze, copper alloy.

B. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Body Material: Cast iron.
3. Closure: Gas and watertight ABS tapered thread plug
4. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group
2. Body Material: Cast iron.
3. Seepage Flange: Required.
4. Anchor Flange: Required.
5. Clamping Device: Required

6. Outlet: Bottom.
7. Sediment Bucket: Required as shown on the drawings.
8. Top or Strainer Material: Nickel bronze except cast iron for drains as noted.
9. Top of Body and Strainer Finish: Polished bronze.
10. Top Shape: Round except rectangular for drains as shown on the drawings..

2.4 ROOF FLASHING ASSEMBLIES

- A. Roof Flashing Assemblies:
 1. Coordinate flashing of vents through roof and other roof penetrations with the type of roof provided.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Floor-Drain, Trap-Seal Primer Fittings:
 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
- B. Sleeve Flashing Device:
 1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
 2. Size: As required for close fit to riser or stack piping.
- C. Stack Flashing Fittings:
 1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 2. Size: Same as connected stack vent or vent stack.

2.6 FLASHING MATERIALS

- A. Flashing materials and methods shall be consistent with the waterproofing membrane being installed.:

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack and roof drain leader.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- H. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
- I. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- J. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- K. Install traps on plumbing specialty drain outlets.

- L. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
- B. Set flashing on floors and roofs in solid coating of bituminous cement.
- C. Secure flashing into sleeve and specialty clamping ring or device.
- D. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings.
- E. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess. Coordinate flashing method with roof system.

3.4 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

END OF SECTION 221319

SECTION 221429 - SUMP PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes sump pumps for the building drainage systems.

1.2 SUBMITTALS

- A. Product Data: Include performance curves, furnished specialties, and accessories for each type and size of pump indicated.
- B. Maintenance Data: For each type and size of pump specified to include in maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, connections, and dimensional requirements of pumps and are based on specific manufacturer types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Submersible Sump Pumps:
 - a. Goulds Pumps, Inc.
 - b. Weil Pump Co.
 - c. Zoeller Pump Co
 - d. Hydromatic.

2.2 SUMP PUMPS, GENERAL

- A. Description: Factory-assembled and -tested, single-stage, centrifugal, end-suction sump pump units complying with UL 778. Include motor, operating controls, and construction for permanent installation.
- B. Discharge Pipe End Connections NPS 2 and Smaller: Threaded. Pumps available only with flanged-end discharge pipe may be furnished with threaded companion flanges.
- C. Discharge Pipe End Connections NPS 2-1/2 and Larger: Flanged.
- D. Motors: Single speed, with grease-lubricated ball bearings, and non-overloading through full range of pump performance curves.
- E. Finish: Manufacturer's standard paint applied to factory-assembled and tested units before shipping.
- F. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembling and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

2.3 SUBMERSIBLE SUMP PUMPS

- A. Description: Submersible, direct-connected sump pump complying with HI 1.1-1.5 for submersible sump pumps.
 - 1. Pump Arrangement: Simplex or Duplex as shown.
 - 2. Casing: Cast iron with cast-iron inlet strainer, legs that elevate pump to permit flow into impeller, and discharge companion flange suitable for plain-end pipe connection arranged for vertical discharge.
 - 3. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, open or semiopen nonclog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
 - 4. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection; and three-conductor waterproof power cable of length required, with grounding plug and cable-sealing assembly for connection at pump.
 - 5. Basin Cover: Cast iron or steel and suitable for supporting controls.
 - 6. Controls: NEMA 250, Type 1 enclosure, pedestal-mounted float switch; with floats, float rods, and rod buttons. Include automatic alternator for duplex installation to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.
 - 7. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mercury-float-switch alarm matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.

2.4 SUMP PUMP BASINS

- A. Description: Factory fabricated with sump, pipe connections, and separate cover.
- B. Basin Sump: Fabricate watertight, with sidewall openings for pipe connections.

1. Material: Fiberglass.
 2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
- C. Basin Cover: Fabricate with openings with gaskets, seals, and bushings, for access, pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
1. Material: Steel, with bitumastic coating or cast iron.
 2. Reinforcement: Steel or cast-iron reinforcement capable of supporting foot traffic for basins installed in foot-traffic areas.

2.5 GENERAL-DUTY VALVES

- A. Refer to Division 22 Section "Valves" for general-duty gate, ball, butterfly, globe, and check valves. Use valves specified for domestic water, unless otherwise indicated. Include features and devices indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of plumbing piping systems to verify actual locations of piping connections before pump installation.

3.2 INSTALLATION

- A. Install pumps according to manufacturer's written instructions.
- B. Install pumps and arrange to provide access for maintenance, including removal of motors, impellers, couplings, and accessories.
- C. Support piping so weight of piping is not supported by pumps.

3.3 ADJUSTING

- A. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.

3.4 COMMISSIONING

- A. Final Checks before Starting: Perform the following preventive maintenance operations:
1. Lubricate bearings.
 2. Disconnect couplings and check motors for proper direction of rotation.
 3. Verify that each pump is free to rotate by hand. Do not operate pump if it is bound or drags, until cause of trouble is determined and corrected.

4. Verify that pump controls are correct for required application.
- B. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:
1. Start motors.
 2. Open discharge valves slowly.
 3. Check general mechanical operation of pumps and motors.

END OF SECTION 221429

SECTION 221603 - FUEL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes fuel gas piping, specialties, and accessories within the building.

1.3 PROJECT CONDITIONS

- A. Design values of fuel gas supplied for these systems are as follows:
 - 1. Nominal Heating Value: 1000 Btu/cu. ft..
 - 2. Nominal Specific Gravity: 0.6.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 2. Pressure regulators. Include pressure rating, capacity, and settings of selected models.
- B. Shop Drawings: For fuel gas piping. Include plans and attachments to other Work.

1.5 QUALITY ASSURANCE

- A. ANSI Standard: Comply with ANSI Z223.1, "National Fuel Gas Code."
- B. UL Standard: Provide components listed in UL's "Gas and Oil Equipment Directory" if specified to be UL listed.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 PIPES, TUBES, FITTINGS, AND JOINING MATERIALS

- A. Steel Pipe: ASTM A 53; Type E or S; Grade B; Schedule 40; black.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
 - 2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
 - 3. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
 - 4. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
 - 5. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
 - 6. Joint Compound and Tape: Suitable for natural gas.
 - 7. Steel Flanges and Flanged Fittings: ASME B16.5.
 - 8. Gasket Material: Thickness, material, and type suitable for natural gas.
- B. Transition Fittings: Type, material, and end connections to match piping being joined.
- C. Common Joining Materials: Refer to Division 22 Section "Basic Mechanical Materials and Methods" for joining materials not in this Section.

2.3 PROTECTIVE COATING

- A. Furnish underground pipe and fittings with factory-applied, corrosion-resistant polyethylene coating for use underground.

2.4 SPECIALTY VALVES

- A. Gas Valves, NPS 2 and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating.
- B. Plug Valves, NPS 2-1/2 and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.
- B. Fuel Gas Piping up to 5 psig: Use the following:
 - 1. NPS 2 and Smaller: Steel pipe, malleable-iron threaded fittings, and threaded joints.
 - 2. NPS 2-1/2 to NPS 4: Steel pipe, steel welding fittings, and welded joints.
 - 3. Larger Than NPS 4: Steel pipe, steel welding fittings, and welded joints.

3.2 PIPING INSTALLATION

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping installation requirements.
- B. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
- C. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- D. Connect branch piping from top or side of horizontal piping.
- E. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
- F. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.
- G. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.
- H. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.
- I. Install containment conduits for gas piping below slabs, within building, in gastight conduits extending minimum of 4 inches outside building, and vented to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal-tar, epoxy-polyamide paint according to SSPC-Paint 16.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 22 Section "Hangers and Supports" for pipe hanger and support devices.
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.

5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.4 CONNECTIONS

- A. Install piping adjacent to appliances to allow service and maintenance.
- B. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.
- C. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.5 PAINTING

- A. Paint exterior piping two coats of exterior grade paint designed to prevent rust and corrosion. Color as selected by the architect.

3.6 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator, and specialty valve.
 1. Refer to Division 22 Section for nameplates and signs.

3.7 FIELD QUALITY CONTROL

- A. Inspect, test, and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing, and Purging," and requirements of authorities having jurisdiction.

3.8 ADJUSTING

- A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

END OF SECTION 221603

SECTION 223400 - FUEL-FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following fuel-fired water heaters:
 - 1. Instantaneous, tankless, gas water heaters.
 - 2. Compression tanks.
 - 3. Water heater accessories.

1.3 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. LEED Submittal:
 - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with ASHRAE/IESNA 90.1-2004, Section 7 - "Service Water Heating."
- C. Shop Drawings: Diagram power, signal, and control wiring.
- D. Product Certificates: For each type of instantaneous water heater, signed by product manufacturer.
- E. Manufacturer Seismic Qualification Certification: Submit certification that commercial water heaters, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- F. Source quality-control test reports.

- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For water heaters to include in emergency, operation, and maintenance manuals.
- I. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period(s): From date of Substantial Completion:
 - a. Instantaneous, Gas Water Heaters:
 - 1) Heat Exchanger: 12 years.
 - 2) Controls and Other Components: 5 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSTANTANEOUS, GAS WATER HEATERS

- A. Description: Comply with ANSI Z21.10.3/CSA 4.3, except storage is not required.
1. Manufacturers:
 - a. RHEEM
 - b. RINNAI INC.
 2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig (1035 kPa).
 - c. Heat Exchanger: Copper tubing.
 - d. Insulation: Comply with ASHRAE 90.2-2004.
 - e. Burner: For use with tankless water heaters and for natural-gas fuel.
 - f. Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
 - g. Temperature Control: Adjustable thermostat.
 - h. Jacket: Metal with enameled finish or plastic.
 3. Support: Bracket for wall mounting.
 4. Capacity and Characteristics:
 - a. Flow Rate: 4.9 gpm (L/s)> at 77 deg F temperature rise.
 - b. Temperature Setting: 120 deg F.
 - c. Fuel Gas Input: 199,900 Btu/h.
 - d. Gas Pressure Required at Burner: 7 inches water column.
 - e. Electrical Characteristics:
 - 1) Volts: 120.
 - 2) Phase: Single.
 - 3) Hertz: 60.
 - f. Minimum Vent Diameter: 3 inches.

2.3 COMPRESSION TANKS

- A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 - 1. Manufacturers:
 - a. AMTROL Inc.
 - b. Wessels Co.
 - 2. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 - 3. Capacity and Characteristics:
 - a. Working-Pressure Rating: 150 psig (1035 kPa).
 - b. Capacity Acceptable: 2 gal. (7.6 L) minimum.
 - c. Air Precharge Pressure: 40 psi.

2.4 WATER HEATER ACCESSORIES

- A. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.
- B. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.
- C. Gas Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.
- D. Combination Temperature and Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select each relief valve with sensing element that extends into storage tank.
 - 1. Gas Water Heaters: ANSI Z21.22/CSA 4.4.
- E. Pressure Relief Valves: Include pressure setting less than working-pressure rating of water heater.
 - 1. Gas Water Heaters: ANSI Z21.22/CSA 4.4.
- F. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- B. Install gas water heaters according to NFPA 54.
- C. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.
- D. Install pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install water heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
- F. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- G. Install pressure gage(s) on[inlet and] outlet piping of commercial, fuel-fired water heater piping. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- H. Charge compression tanks with air.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect[, test, and adjust] field-assembled components and equipment installation, including connections[, and to assist in field testing]. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain instantaneous water heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 223400

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Faucets
2. Flush valves
3. Fixture supports.
4. Water closets.
5. Urinals.
6. Lavatories.
7. Sinks.
8. Water coolers
9. Showers

1.2 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- C. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

PART 2 - PRODUCTS

2.1 FAUCETS

A. Lavatory Faucets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Moen Faucets.
 - b. Delta Faucet Company.

2.2 FLUSH VALVES

A. Flushometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sloan Valve Company (Sloan Royal only).
 - b. Zurn Plumbing Products Group; Commercial Brass Operation.

2.3 TOILET SEATS

A. Toilet Seats:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Standard Companies, Inc.
 - b. Bemis Manufacturing Company.
 - c. Church Seats.
 - d. Eljer.
 - e. Kohler Co.
 - f. Olsonite Corp.

2.4 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
 - b. McGuire Manufacturing Co., Inc.
 - c. Plumberex Specialty Products Inc.
 - d. TRUEBRO, Inc.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.5 FIXTURE SUPPORTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Josam Company.
 2. Zurn Plumbing Products Group; Specification Drainage Operation.
- B. Water-Closet Supports:
 1. Description: Combination carrier designed for accessible or standard mounting height as indicated of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
- C. Urinal Supports:
 1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
 2. Accessible-Fixture Support: Include rectangular steel uprights.
- D. Lavatory Supports:
 1. Description: Type II, lavatory carrier with concealed arms and tie rod III or lavatory carrier with hanger plate and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
 2. Accessible-Fixture Support: Include rectangular steel uprights.
- E. Sink Supports:
 1. Description: Type II, sink carrier with hanger plate, bearing studs, and tie rod or III, sink carrier with hanger plate and exposed arms for sink-type fixture. Include steel uprights with feet.

2.6 WATER CLOSETS

- A. Water Closets:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kohler
 - b. American Standard Companies, Inc.

2.7 URINALS

A. Urinals:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kohler Co
 - b. American Standard Companies, Inc.

2.8 KITCHEN SINKS

A. Kitchen Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kohler Co.
 - b. Elkay Manufacturing Co.
 - c. Just Manufacturing Company.
 - d. American Standard

2.9 SERVICE SINKS

A. Service Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Plumbing, L.L.C./Fiat Products.
 - b. Florestone

2.10 MOP SERVICE BASIN

A. Mop Service Basin:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Florestone
 - b. Fiat Products.

2.11 HOSE BIBBS AND HYDRANTS

A. Hose Bibbs and Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Woodford

- b. Zurn

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- D. Install wall-mounting fixtures with tubular waste piping attached to supports.
- E. Install fixtures level and plumb according to roughing-in drawings.
- F. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- G. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- H. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- I. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- J. Install escutcheons at piping wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings.
- K. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.3 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.

3.4 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

3.5 PLUMBING FIXTURE SCHEDULE

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.
- C. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified below and in other Part 2 articles.

"See drawings for fixture schedule"

END OF SECTION 224000

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Grout.
7. HVAC demolition.
8. Equipment installation requirements common to equipment sections.
9. Concrete bases.
10. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 SUBMITTALS

- A. Welding certificates.
- B. Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, and identification materials and devices.
- C. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

- D. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Show access panels and door locations. Include the following:
1. Planned piping layout, including valve and specialty locations and valve-stem movement.
 2. Planned ductwork layout of mechanical rooms and other congested spaces.
 3. Clearances for installing and maintaining insulation.
 4. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 5. Equipment and accessory service connections and support details.
 6. Exterior wall and foundation penetrations.
 7. Fire-rated wall and floor penetrations.
 8. Sizes and location of required concrete pads and bases. Coordinate floor drain locations.
 9. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 10. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 11. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.
- E. Samples: Of color, lettering style, and other graphic representation required for each identification material and device.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.5 COORDINATION OF TRADES

- A. Check, verify and coordinate work with other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with the building structure or other trades.

- B. Drawings and specifications are necessarily schematic in nature and cannot describe completely all situations that might be encountered in the field. It is the responsibility of the contractor to familiarize himself with the scope of work required and include all work indicated or reasonably implied by the contract documents.
- C. Layout the work to prevent conflict with, and to co-ordinate with work of other trades. Systems shall generally be run in a rectilinear fashion.
- D. Each trade is responsible for the coordination of their work with all other work at the site prior to beginning in each area.
- E. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- F. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- G. Coordinating space requirements, supports, and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- H. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

- F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

1.7 DIVISION OF WORK (Division 23/26)

- A. This section delineates the division of work between Division 23 and Division 26.
- B. Specific work to be done under Division 26 is hereinafter listed or described. All other work necessary for the operation of Division 23 equipment shall be performed under Division 23.
- C. All individual motor starters for mechanical equipment (fans, pumps, etc.) shall be furnished and installed under Division 23 unless indicated as a part of a motor control center. Motor starters for mechanical equipment provided in motor control centers shall be furnished under Division 26.
- D. Under Division 26, power wiring shall be provided up to a termination point consisting of a junction box, trough, starter or disconnect switch. Under Division 26 line side terminations shall be provided. Wiring from the termination point to the mechanical equipment, including final connections, shall be provided under Division 23.
- E. Duct smoke detectors shall be furnished and wired by Division 26, installed by Division 23. Fire alarm AHU shut down circuits shall be wired from the fire alarm control panel to a termination point, adjacent to the AHU control, under Division 26. AHU control wiring from the termination point to the equipment shall be under Division 23.
- F. All relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric, and electric-pneumatic switches, aquastats, freezestats, line and low voltage thermostats, thermals, remote selector switches, remote pushbutton stations, emergency break-glass stations, interlocking, disconnect switches beyond termination point, and other appurtenances associated with equipment under Division 23 shall be furnished, installed and wired under Division 23.
- G. All wiring required for controls and instrumentation not indicated on the drawings shall be furnished and installed by Division 23.
- H. Roof exhaust fans with built-in disconnects provided under Division 23 shall be wired under Division 26 to the line side of the disconnect switch. A disconnect switch shall be provided under Division 26 if the fan is not provided with a built-in disconnect switch. In this case wiring from the switch to the fan shall be under Division 23.

- I. The sequence of control for all equipment shall be as indicated on the Division 23 Drawings and specified in Section, HVAC Control System.
- J. All sprinkler flow and tamper switches shall be furnished and installed under Division 23, and wired under Division 26.
- K. Where electrical wiring is required by trades other than covered by Division 26, specifications for that section shall refer to same wiring materials and methods as specified under Division 26. No Exceptions.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- E. Welding Filler Metals: Comply with AWS D10.12.

2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: Chrome plated
- D. Split-Casting, Cast-Brass Type: chrome plated with concealed hinge and set screw.

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.

- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials. Submit UL through-penetration details for each system and type of penetration. All firestopping materials to be of same manufacturer.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000 psi, 28-day compressive-strength concrete and reinforcement.."

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.7 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Place grout, completely filling equipment bases.
- E. Place grout on concrete bases and provide smooth bearing surface for equipment.

END OF SECTION 230500

SECTION 230505 – ROOF CURBS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Roof curbs.
2. Equipment supports.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, materials, dimensions of individual components and profiles, and finishes.

1.3 QUALITY ASSURANCE

A. Standards: Comply with the following:

1. SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.
2. NRCA's "Roofing and Waterproofing Manual" details for installing units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Roof Curbs and Equipment Supports:
 - a. Pate Co.(The)
 - b. Loren Cook Company.
 - c. Roof Products & Systems Corp.
 - d. ThyCurb, Inc.
 - e. Vent Products Co., Inc.

2.2 MATERIALS, GENERAL

- A. Aluminum Sheet: ASTM B 209 for alclad alloy 3005H25 or alloy and temper required to suit forming operations, with mill finish, unless otherwise indicated.
- B. Extruded Aluminum: ASTM B 221 alloy 6063-T52 or alloy and temper required to suit structural and finish requirements, with mill finish, unless otherwise indicated.
- C. Galvanized Steel Sheet: ASTM A 653/A 653M with G90 coating designation; commercial quality, unless otherwise indicated.
- D. Insulation: Manufacturer's standard rigid or semirigid glass-fiber board of thickness indicated, not less than 1 ½".
- E. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, complying with AWPA C2; not less than 1-1/2 inches thick.
- F. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by manufacturer. Match finish of exposed fasteners with finish of material being fastened.

2.3 ROOF CURBS

- A. General: Provide insulated roof curbs capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs.
- B. Fabrication: Unless otherwise indicated or required for strength, fabricate units from minimum 0.0747-inch- thick, structural-quality, hot-dip galvanized or aluminum-zinc alloy-coated steel sheet; factory primed and prepared for painting with welded or sealed mechanical corner joints.
 - 1. Provide preservative-treated wood nailers at tops of curbs and formed flange at perimeter bottom for mounting to roof.
 - 2. Provide manufacturer's standard rigid or semirigid insulation where indicated.
 - 3. Provide formed cants and base profile coordinated with roof insulation thickness.
 - 4. Fabricate units to minimum height of 12 inches, unless otherwise indicated.
 - 5. Sloping Roofs: Fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.
 - 6. Insulate curb with 1 ½" thick insulation to provide a continuous thermal envelope.
 - 7. Provide extended height curbs where required for kitchen hood exhaust.

2.4 EQUIPMENT SUPPORTS

- A. General: Provide equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported.

- B. Fabrication: Unless otherwise indicated or required for strength, fabricate units from structural-quality, hot-dip galvanized or aluminum-zinc alloy-coated steel sheet; factory primed and prepared for painting with welded or sealed mechanical corner joints. Provide preservative-treated wood nailers at tops of curbs and formed flange at perimeter bottom for mounting to roof. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile. Fabricate units to minimum height of 12 inches above the finished roof, unless otherwise indicated. Fabricate support units with height tapered to match slope to level tops of units.
- C. Provide 3000 psi concrete reinforced with 6x6x6 WWF, housekeeping pads for all slab mounted equipment. Chamfer pad edges 1/2".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with manufacturer's written instructions. Coordinate installation of roof accessories with installation of roof deck, roof insulation, flashing, roofing membranes, penetrations, equipment, and other construction involving roof accessories to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight. Anchor roof accessories securely to supporting structural substrates so they are capable of withstanding lateral and thermal stresses, and inward and outward loading pressures.
- B. Cap Flashing: Where required as component of accessory, install cap flashing to provide waterproof overlap with roofing or roof flashing (as counterflashing). Seal overlap with thick bead of mastic sealant.

3.2 CLEANING AND PROTECTION

- A. Clean exposed surfaces according to manufacturer's written instructions. Touch up damaged metal coatings.

END OF SECTION 230505

SECTION 230513 - COMMON MOTOR AND CONTROLLER REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 SUBMITTALS

- A. Product Data for Field-Installed Motors: For each type and size of motor, provide nameplate data and ratings; shipping, installed, and operating weights; mounting arrangements; size, type, and location of winding terminations; conduit entry and ground lug locations; and information on coatings or finishes.
- B. Operation and Maintenance Data: For field-installed motors to include in emergency, operation, and maintenance manuals.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:
 - 1. Compatible with the following:
 - a. Magnetic controllers.
 - b. Multispeed controllers.
 - c. Reduced-voltage controllers.
 - 2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
 - 3. Matched to torque and horsepower requirements of the load.
 - 4. Matched to ratings and characteristics of supply circuit and required control sequence.

PART 2 - PRODUCTS

2.1 MOTOR REQUIREMENTS

- A. Motor requirements apply to factory-installed and field-installed motors except as follows:
 - 1. Different ratings, performance, or characteristics for a motor are specified in another Section.

2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

2.2 MOTOR CHARACTERISTICS

- A. Motors 1/2 HP and Larger: Three phase.
- B. Motors Smaller Than 1/2 HP: Single phase.
- C. Frequency Rating: 60 Hz.
- D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
- E. Service Factor: 1.15 for open drip proof motors; 1.0 for totally enclosed motors.
- F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
- G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- H. Enclosure: Open drip proof for general use, weatherproof, explosion proof, etc., as required for special duty application.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Comply with requirements of the NCSBC and EPACT and NEMA Table 12.6C, but at a minimum meet or exceed value listed in following table.

Minimum Full Load Efficiency				Minimum Full Load Efficiency			
Open Motors				Enclosed Motors			
Rating HP	3600 RPM 2-POLE	1800 RPM 4-POLE	1200 RPM 6-POLE	Rating HP	3600 RPM 2-POLE	1800 RPM 4-POLE	1200 RPM 6-POLE
1		82.5	80.0	1	75.5	82.5	80.0
1.5	82.5	84.0	84.0	1.5	82.5	84.0	85.5

2	84.0	84.0	85.5	2	84.0	84.0	86.5
3	84.0	86.5	86.5	3	85.5	87.5	87.5
5	85.5	87.5	87.5	5	87.5	87.5	87.5
7.5	87.5	88.5	88.5	7.5	88.5	89.5	89.5
10	88.5	89.5	90.2	10	89.5	89.5	89.5
15	89.5	91.0	90.2	15	90.2	91.0	90.2
20	90.2	91.0	91.0	20	90.2	91.0	90.2
25	91.0	91.7	91.7	25	91.0	92.4	91.7
30	91.0	92.4	92.4	30	91.0	92.4	91.7
40	91.7	93.0	93.0	40	91.7	93.0	93.0
50	92.4	93.0	93.0	50	92.4	93.0	93.0
60	93.0	93.6	93.6	60	93.0	93.6	93.6
75	93.0	94.1	93.6	75	93.0	94.1	93.6
100	93.0	94.1	94.1	100	93.6	94.5	94.1
125	93.6	94.5	94.1	125	94.5	94.5	94.1
150	93.6	95.0	94.5	150	94.5	95.0	95.0
200	94.5	95.0	94.5	200	95.0	95.0	95.0

- C. Stator: Copper windings, unless otherwise indicated.
- D. Rotor: Squirrel cage, unless otherwise indicated.
- E. Bearings: Double-shielded, ball bearings suitable for radial and thrust loading.
- F. Temperature Rise: Match insulation rating, unless otherwise indicated.

- G. Insulation: Class F, unless otherwise indicated.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Designed with critical vibration frequencies outside operating range of controller output.
 - 2. Temperature Rise: Matched to rating for Class B insulation.
 - 3. Insulation: Class H.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

- A. Type: One of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
- B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.
- C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, sleeve type for other single-phase motors.

2.6 CONTROLLERS AND CONTROLS:

- A. Controllers shall conform to adopted standards and recommended practices of the Industrial Control Standards of the National Electrical Manufacturers Association and the standard for Industrial Control Equipment of the Underwriters Laboratories, Inc. Single phase motors shall be provided with integral overload protection.
- B. Two (2) speed, three phase motors shall be one winding consequent pole type.
- C. Magnetic starters for motors 50 hp and smaller shall be full voltage, across the line type with undervoltage release for manual or automatic operation and shall break all phases on 3 phase starters.
- D. Starters for motors 60 hp and above shall be reduced voltage type. Starters shall be provided with start-stop pushbuttons mounted on cover unless controlled by hand-off-

automatic device. Hand-off-automatic device shall not be wired to override safety device interlocks on starter mounted on or adjacent to starter except where indicated on plans. If selector is mounted remotely, provide test start pushbutton on starter. All auxiliary contacts required for interlocking purposes shall be furnished and installed with starter. All manual motor starters shall be quick-make, quick-break, toggle action types with one-piece melting alloy type thermal units and pilot light.

- E. Starters shall be provided with proper size thermal elements which shall be of one-piece, interchangeable construction. The starter shall not operate with any element removed. All starters installed outdoors shall be provided with ambient temperature compensating motor overload devices. All starter enclosures shall be NEMA 1, indoors and NEMA 3R in exterior areas, unless noted otherwise.
- F. All starters and pushbutton stations shall be provided with labels as specified under identification designating service for which starter is used. Plate shall be firmly attached to starter or wall mounted adjacent to starter.
- G. Provide thermal element selection chart on the inside of each starter door.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
 - 2. Test interlocks and control features for proper operation.
 - 3. Verify that current in each phase is within nameplate rating.

3.2 ADJUSTING

- A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.3 CLEANING

- A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean motors, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 230513

SECTION 230514 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes solid-state, PWM, VFDs for speed control of three-phase, squirrel-cage induction motors.

1.2 DEFINITIONS

- A. BMS: Building management system.
- B. IGBT: Integrated gate bipolar transistor.
- C. LAN: Local area network.
- D. PID: Control action, proportional plus integral plus derivative.
- E. PWM: Pulse-width modulated.
- F. VFD: Variable frequency drive.

1.3 SUBMITTALS

- A. Product Data: For each type of VFD, provide dimensions; mounting arrangements; location for conduit entries; shipping and operating weights; and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- B. Shop Drawings: For each VFD.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current ratings of integrated unit.
 - 2. Wiring Diagrams: Power, signal, and control wiring for VFD. Provide schematic wiring diagram for each type of VFD.
- C. Operation and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals.
 - 1. Routine maintenance requirements for VFDs and all installed components.

- 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
 - E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.
- 1.4 QUALITY ASSURANCE
- A. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
 - B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - C. Comply with NFPA 70.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- 1.6 COORDINATION
- A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
 - B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
 - C. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.
 - D. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Graham.
 - 2. MagneTek Drives and Systems.
 - 3. Toshiba International Corporation.
 - 4. Yakasawa
 - 5. ABB

2.2 VARIABLE FREQUENCY DRIVES

- A. Description: NEMA ICS 2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of a NEMA MG 1, Design B, 3-phase, induction motor by adjusting output voltage and frequency.
- B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
- D. Unit Operating Requirements:
 - 1. Input ac voltage tolerance of 380 to 500 V, plus or minus 10 percent
 - 2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
 - 3. Capable of driving full load, under the following conditions, without derating:
 - a. Ambient Temperature: 0 to 40 deg C.
 - b. Humidity: Less than 90 percent (non-condensing).
 - c. Altitude: 3300 feet .
 - 4. Minimum Efficiency: 96 percent at 60 Hz, full load.
 - 5. Minimum Displacement Primary-Side Power Factor: 96 percent.
 - 6. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
 - 7. Starting Torque: 100 percent of rated torque or as indicated.
 - 8. Speed Regulation: Plus or minus 1 percent.
 - 9. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
- E. Control Signal Interface: Provide VFD with the following:

1. Electric Input Signal Interface: A minimum of 3 analog inputs (0 to 10 V or 0/4-20 mA) and 8 programmable digital inputs.
2. Output Signal Interface:
 - a. A minimum of 2 programmable analog output signals and two programmable relay outputs.
- F. Communications: Provide an RS485 interface.
- G. Integral Disconnecting Means: NEMA AB 1, service disconnect with lockable handle.
- H. Bypass: Is required
- I. Internal Adjustability Capabilities:
 1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 2 to a minimum of 22 seconds.
 4. Deceleration: 2 to a minimum of 22 seconds.
 5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
- J. Self-Protection and Reliability Features:
 1. Input transient protection by means of surge suppressors.
 2. Snubber networks to protect against malfunction due to system voltage transients.
 3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
 4. Motor Overload Relay: Adjustable and capable of NEMA 250 performance.
 5. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 6. Instantaneous line-to-line and line-to-ground overcurrent trips.
 7. Loss-of-phase protection.
 8. Reverse-phase protection.
 9. Short-circuit protection.
 10. Motor overtemperature fault.
 11. Integral input line reactor option to lower total current harmonic distortion to prevent nuisance main breaker tripping and extend life of motor.
 12. Bypass with the bypass control circuitry protected by undervoltage relay protection
- K. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled fan-ventilated motors at slow speeds.
- L. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
 1. Power on.
 2. Run.
 3. Overvoltage.

4. Line fault.
 5. Overcurrent.
 6. External fault.
- M. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.
- N. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hz).
 2. Motor speed (rpm).
 3. Motor status (running, stop, fault).
 4. Motor current (amperes).
 5. Motor torque (percent).
 6. Fault or alarming status (code).
 7. PID feedback signal (percent).
 8. DC-link voltage (VDC).
 9. Set-point frequency (Hz).
 10. Motor output voltage (V).
- O. Control Signal Interface: Provide VFD with the following:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
 2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
 - a. 0 to 10-V dc.
 - b. 0-20 or 4-20 mA.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 - e. RS485.
 - f. Keypad display for local hand operation.
 3. Output Signal Interface:
 - a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
 - 1) Output frequency (Hz).
 - 2) Output current (load).
 - 3) DC-link voltage (VDC).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set-point frequency (Hz).
 4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - a. Motor running.

- b. Set-point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high or low speed limits reached.
- P. Communications: Provide an RS485 interface allowing VFD to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFD to be programmed via BMS control. Provide capability for VFD to retain these settings within the nonvolatile memory.
- Q. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.
- R. VFD to have internal line bus reactor and an undervoltage/overvoltage protection relay to protect the bypass control circuitry

2.3 ENCLOSURES

- A. NEMA 1

2.4 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- D. Control Relays: Auxiliary and adjustable time-delay relays.
- E. Standard Displays:
 - 1. Output frequency (Hz).
 - 2. Set-point frequency (Hz).
 - 3. Motor current (amperes).
 - 4. DC-link voltage (VDC).
 - 5. Motor torque (percent).
 - 6. Motor speed (rpm).
 - 7. Motor output voltage (V).
- F. Historical Logging Information and Displays:
 - 1. Real-time clock with current time and date.
 - 2. Running log of total power versus time.
 - 3. Total run time.
 - 4. Fault log, maintaining last four faults with time and date stamp for each.

- G. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.5 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFDs before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, drive, and load.
- B. Select rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. Anchor each VFD assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with VFD mounting surface.
- B. Install VFDs on concrete bases.
- C. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 IDENTIFICATION

- A. Identify VFDs, components, and control wiring according to Division 26 Section.

- B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.5 CONNECTIONS

- A. Ground equipment.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 STARTUP SERVICE

- A. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.
- B. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.8 CLEANING

- A. Clean VFDs internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain VFDs.

END OF SECTION 230514

SECTION 230516 - PIPE EXPANSION FITTINGS AND LOOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes pipe expansion fittings and loops for mechanical piping systems, and the following:
 - 1. Pipe bends and loops.
 - 2. Guides and anchors.

1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products suitable for piping system fluids, materials, working pressures, and temperatures.
- B. Capability: Absorb 200 percent of maximum piping expansion between anchors.

1.4 SUBMITTALS

- A. Product Data: For each type of expansion fitting indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer.
 - 1. Design Calculations: For thermal expansion of piping systems and selection and design of expansion fittings and loops.
 - 2. Anchor Details: Detail fabrication of each indicated. Show dimensions and methods of assembly.
 - 3. Alignment Guide Details: Detail field assembly and anchorage.
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.
- D. Schedule: Indicate manufacturer's number, size, location, and features for each expansion fitting and loop.

1.5 QUALITY ASSURANCE

- A. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for expansion fittings and loops by a qualified professional engineer.

1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of expansion fittings and loops that are similar to those indicated for this Project in material, design, and extent.
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

PART 2 - PRODUCTS

2.1 GUIDES

- A. Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

2.2 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.
- C. Washers: ASTM F 844, steel, plain, flat washers.
- D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.
 1. Stud: Threaded, zinc-coated carbon steel.
 2. Expansion Plug: Zinc-coated steel.
 3. Washer and Nut: Zinc-coated steel.
- E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.
 1. Bonding Material: ASTM C 881, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 3. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 PIPE BEND AND LOOP INSTALLATION

- A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Attach pipe bends and loops to anchors.
 - 1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.2 SWING CONNECTIONS

- A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.3 GUIDE INSTALLATION

- A. Install guides on piping adjoining expansion fittings and loops.
- B. Attach guides to pipe and secure to building structure.

3.4 ANCHOR INSTALLATION

- A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.
- C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.
- D. Install pipe anchors according to expansion fitting manufacturer's written instructions if expansion fittings are indicated.
- E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION 230516

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes meters and gages for mechanical systems.
- B. Related Sections include the following:
 - 1. Mechanical equipment Sections that specify meters and gages as part of factory-fabricated equipment.

1.2 SUBMITTALS

- A. Product Data: Include scale range, ratings, and calibrated performance curves for each meter, gage, fitting, specialty, and accessory specified.
- B. Product Certificates: Signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and compliance with specified requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Thermometers:
 - a. Weksler Instruments Operating Unit.
 - b. Ernst Gage Co.
 - c. Palmer Instruments, Inc.
 - d. H. O. Trerice Co.
 - e. Weiss Instruments, Inc.
 - f. Ashcroft Commercial Sales Operation.
 - 2. Pressure Gages:
 - a. Ashcroft Commercial Sales Operation.
 - b. Weksler Instruments.
 - c. Ernst Gage Co.
 - d. Marsh Bellofram.

- e. Terice: H. O. Terice Co.
- f. Weiss Instruments, Inc.

2.2 THERMOMETERS, GENERAL

- A. Scale Range: Temperature ranges for services listed are as follows:
 - 1. All services: -40 to 300 deg F.
- B. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span, 1/10°F resolution.

2.3 DIGITAL THERMOMETERS

- A. Description: Variable angle, light powered, digital thermometer.
- B. Case: High impact ABS.
- C. Display: 3/8" LCD digits, wide ambient formula.
- D. Lux rating: 10 lux (1 foot candle)
- E. Update: 10 seconds
- F. Ambient operating temperature: -30°F to 140°F
- G. Sensor: Glass passivated thermistor
- H. Stem assembly: Industrial glass type
- I. Fahrenheit to Celsius switchable
- J. Weiss Vari-angle Digital thermometer or equal

2.4 SEPARABLE SOCKETS

- A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.
 - 1. Material: Brass, for use in copper piping.
 - 2. Material: Stainless steel, for use in steel piping.
 - 3. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.
 - 4. Insertion Length: To extend to one-third of diameter of pipe.
 - 5. Cap: Threaded, with chain permanently fastened to socket.
 - 6. Heat-Transfer Fluid: Oil or graphite.

2.5 THERMOMETER WELLS

- A. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.
 - 1. Material: Brass, for use in copper piping.
 - 2. Material: Stainless steel, for use in steel piping.
 - 3. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.
 - 4. Insertion Length: To extend to one-third of diameter of pipe.
 - 5. Cap: Threaded, with chain permanently fastened to socket.

2.6 PRESSURE GAGES

- A. Description: ASME B40.1, phosphor-bronze bourdon-tube type with bottom connection; dry type, unless liquid-filled-case type is indicated.
- B. Case: Stainless steel with 4-1/2-inch- diameter, plastic lens.
- C. Connector: Brass, NPS 1/4.
- D. Scale: White background with bold black numerals and graduations.
- E. Pointer: Balanced, adjustable, black pointer
- F. Accuracy: Grade A, plus or minus 1 percent of middle 50 percent of scale.
- G. Range: Comply with the following:
 - 1. Vacuum: 30 inches Hg of vacuum to 15 psig of pressure.
 - 2. Fluids under Pressure: Two times the operating pressure.

2.7 PRESSURE-GAGE FITTINGS

- A. Valves: NPS 1/4 copper or bronze ball valve.
- B. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
- C. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.8 TEST PLUGS

- A. Description: Nickel-plated, brass-body test plug in NPS 1/2 fitting.
- B. Body: Length as required to extend beyond insulation.
- C. Pressure Rating: 500 psig minimum.
- D. Core Inserts: One or two self-sealing valves, suitable for inserting 1/8-inch OD probe from dial-type thermometer or pressure gage.

- E. Test-Plug Cap: Gasketed and threaded cap, with retention chain or strap.
- F. Test Kit: Pressure gage and adapter with probe, two bimetal dial thermometers, and carrying case.
 - 1. Pressure Gage and Thermometer Ranges: Approximately two times the system's operating conditions.

PART 3 - EXECUTION

3.1 METER AND GAGE INSTALLATION, GENERAL

- A. Install meters, gages, and accessories according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

- A. Install thermometers and adjust vertical and tilted positions.
- B. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.
- C. Install thermometers on cold water inlet and hot water outlet of each domestic water heater.

3.3 PRESSURE-GAGE INSTALLATION

- A. Install pressure gages in piping tees with pressure-gage valve located on pipe at most readable position.
- B. Install pressure gages in the following locations:
 - 1. Upstream and downstream of each pressure-reducing valve.
 - 2. Building water-service entrance.
- C. Install liquid-filled-type pressure gages at suction and discharge of each pump.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:
 - 1. Install meters and gages adjacent to machines and equipment to allow service and maintenance.

3.5 ADJUSTING AND CLEANING

- A. Calibrate meters according to manufacturer's written instructions, after installation.
- B. Adjust faces of meters and gages to proper angle for best visibility.
- C. Clean windows of meters and gages and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 230519

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. High-performance butterfly valves.
4. Bronze swing checks valves.
5. Iron swing check valves.
6. Iron swing check valves with closure control.
7. Bronze gate valves.
8. Iron gate valves.
9. Bronze globe valves.
10. Iron globe valves.

B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.2 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.3 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

PART 2 - PRODUCTS

2.1 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

- C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
 - D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
 - E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
 - F. Valve Actuators:
 - 1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
 - 2. Gear Drive: For quarter-turn valves NPS 8 and larger.
 - 3. Handwheel: For valves other than quarter-turn types.
 - 4. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
 - 5. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
 - G. Extended Valve Stems: On insulated valves.
 - H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
 - I. Valve Grooved Ends: AWWA C606.
 - 1. Solder Joint: With sockets according to ASME B16.18.
 - a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.
 - 2. Threaded: With threads according to ASME B1.20.1.
 - J. Valve Bypass and Drain Connections: MSS SP-45.
- 2.2 BALL VALVES
- A. Copper-Alloy Ball Valves, General: MSS SP-110.
 - B. Three-Piece, Copper-Alloy Ball Valves: Brass or bronze body with regular-port, chrome-plated bronze ball; PTFE or TFE seats; and 300-psig minimum CWP rating and blowout-proof stem. 150 psi WSP, all bronze, adjustable packing nut, three (3) piece design, (permits inspection and repair of seats and seals without removing the valve from the line), standard port, screwed or solder connections. Ball valves shall be used for shut-off in sizes 3" and under. Provide extended stems for insulated piping.
- 2.3 FERROUS-ALLOY BUTTERFLY VALVES
- A. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, Type I, for tight shutoff, with disc and lining suitable for potable water, unless otherwise indicated.
 - B. Flanged, 150-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Full lug Flanged-end type .

- C. Butterfly valves shall have ductile iron body, bronze floating type disc, EPT seat, 416 stainless steel dry journal type stems, bronze bearings. Bodies shall be full lug type with extended necks adequate for the appropriate insulation thickness. Operators shall be 10 position positive lock lever type in sizes 4" to 6", and worm gear operators for 8" and above

2.4 BRONZE CHECK VALVES

- A. Bronze Check Valves, General: MSS SP-80.
- B. Type 1, Class 150, Bronze, Horizontal Lift Check Valves: Bronze body with bronze disc and seat.

2.5 GRAY-IRON SWING CHECK VALVES

- A. Gray-Iron Swing Check Valves, General: MSS SP-71.
- B. Type I, Class 125, gray-iron, swing check valves with metal seats.

2.6 FERROUS-ALLOY WAFER CHECK VALVES

- A. Ferrous-Alloy Wafer Check Valves, General: API 594, spring loaded.
- B. Dual-Plate, Class 125 or 150, Ferrous-Alloy, Wafer-Lug Check Valves: Single-flange body.

2.7 SPRING-LOADED, LIFT-DISC CHECK VALVES

- A. Lift-Disc Check Valves, General: FCI 74-1, with spring-loaded bronze or alloy disc and bronze or alloy seat.
- B. Type I, Class 125, Wafer Lift-Disc Check Valves: Wafer style with cast-iron shell with diameter matching companion flanges.

2.8 BRONZE GATE VALVES

- A. Bronze Gate Valves, General: MSS SP-80, with ferrous-alloy handwheel.
- B. Type 2, Class 150, Bronze Gate Valves: Bronze body with rising stem and bronze wedge.

2.9 CAST-IRON GATE VALVES

- A. Cast-Iron Gate Valves, General: MSS SP-70, Type I.
- B. Class 125, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, rising stem, and solid-wedge disc.

2.10 BRONZE GLOBE VALVES

- A. Bronze Globe Valves, General: MSS SP-80, with ferrous-alloy handwheel.
- B. Type 1, Class 150, Bronze Globe Valves: Bronze body with bronze disc.
- C. Cast-Iron Globe Valves, General: MSS SP-85.
- D. Type I, Class 125, Cast-Iron Globe Valves: Gray-iron body with bronze seats.

2.11 CHAINWHEEL ACTUATORS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Sprocket Rim with Chain Guides: Ductile iron of type and size required for valve. Include zinc coating.
 - 2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 3. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly, or gate, valves.
 - 2. Throttling Service: Angle, ball, butterfly, or globe valves.
 - 3. Pump Discharge: Spring-loaded, lift-disc check valves.

- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Chilled-Water Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2 and Smaller Three piece, 400-psig CWP rating, copper alloy.
 - 2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
 - 3. Butterfly Valves, NPS 2-1/2 and Larger: Flanged full lug body, 150-psig CWP rating, ferrous alloy, with EPDM liner.
 - 4. Wafer Check Valves, NPS 2-1/2 and Larger Dual-plate, wafer-lug, Class 150 ferrous alloy.
 - 5. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 150.
 - 6. Butterfly Valves, NPS 2-1/2 and Larger: Flanged, full lug type 150-psig CWP rating, ferrous alloy, with EPDM liner.
 - 7. Wafer Check Valves, NPS 2-1/2 and Larger Dual-plate, wafer-lug, Class 150 ferrous alloy.
 - 8. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 150.
- D. Domestic Water Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2 and Smaller Three piece, 400-psig]CWP rating, copper alloy.
 - 2. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 150.
 - 3. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 150, bronze.
- E. Heating Water Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2 and Smaller Three piece, 400-psig CWP rating, copper alloy.
 - 2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
 - 3. Butterfly Valves, NPS 2-1/2 and Larger: Flanged, full lug type 150-psig CWP rating, ferrous alloy, with EPDM liner.
 - 4. Wafer Check Valves, NPS 2-1/2 and Larger Dual-plate, wafer-lug, Class 150 ferrous alloy.
 - 5. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 150.
- F. Select valves, except wafer and flangeless types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged [or threaded] ends.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.

- E. Install valves in position to allow full stem movement.
- F. Install chainwheel operators on valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor elevation.
- G. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes hangers and supports for mechanical system piping and equipment.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design heavy-duty steel trapezes and/or support channels for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.4 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
- B. All bracket, clamp and rod sizes indicated are minimum sizes only. The installing trade shall be responsible for structural integrity of all supports. All structural hanging materials shall have a safety factor of 5 built in and shall comply with MSS Standard SP-69.
- C. All hangers, supports, fasteners, etc. for outdoor installation shall be hot dip galvanized, indoor hangers may be painted or galvanized. All hanger rod shall be hot dip galvanized or cadmium plated.
- D. Supports for uncovered copper tubing shall be especially designed for copper tubing, shall be of exact outside diameter of tubing and shall be copper plated
- E. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
 - 1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

2.2 MISCELLANEOUS MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 2. Properties: Non-staining, noncorrosive, and nongaseous.
 3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections. Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

Description	Type
Insulation Protection Shield	40
Pipe saddle	39
Clevis hanger	1
Roller hanger	43
Clevis	14
Eye Nut	17
Eye Socket	16
U-bolt	24
Copper Tubing Hanger	10
Beam Clamp	23

Pipe Roller Stand	44 and 46
Pipe Clamp	4 and 3
Riser Clamp	8
Center Load Beam Clamp	21
Wall Bracket	32 and 33
Welded Beam Attachment	22
Concrete Insert	18
Turnbuckle	13

C. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Supports, anchors, hangers and guides per MSS SP-69 shall be provided for all horizontal and vertical piping. Hangers shall be so arranged as to prevent excessive deflection and avoid excessive bending stresses. Clevis type hangers shall be used for support of "cold" or ambient temperature piping systems, provide galvanized insulation shields with flared ends for insulated piping. Roller type supports shall be used for hot pipes subject to axial movement. Supports shall be braced so that movement occurs in roller rather than support rods. Provide beam clamps, turnbuckles, struts, channels, angle iron, and miscellaneous supports as required for a complete installation. Pipe hangers shall be installed no further than 24" from any change of direction. Contractor shall bear all responsibility for materials and workmanship as described in this section and shall make sure that all hangers and supports are properly and permanently connected to building structure.
- C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
1. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.4 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

END OF SECTION 230529

SECTION 230533 - HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes heating cables for the following applications:
 - 1. Heat tracing.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Maintenance Data: For electric heating cables to include in maintenance manuals.
- C. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 COORDINATION

- A. Coordinate layout and installation of electric heating cables and system components with other construction.

1.6 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Two years from date of Project Closeout.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Thermon Heat Tracing Systems.
 2. Chromalox; Wiegard Industrial Division; Emerson Electric Company.
 3. Delta-Therm Corp.
 4. INDEECO.
 5. Raychem Corporation.

2.2 HEATING CABLES

- A. Heat-Tracing Cables: Self-regulating, electric heating cables suitable for freeze protection of metal or plastic piping.
1. Cables: Pair of parallel No. 16 AWG tinned-copper bus wires embedded in cross-linked conductive polymer core, which varies power output in response to temperature along its length.
 2. Cable shall be capable of crossing over itself without overheating.
 3. Cable Cover: Fabricated of cross-linked, modified, polyolefin dielectric jacket; tinned-copper braid; and polyolefin outer jacket with ultraviolet inhibitor.
 4. Heat Output: Shall be sized according to the table below. The required heating cable output is in watts per foot at 50 degrees (F).

Pipe Size (in.)	Minimum Ambient -10F
3 or less	5 watts
4	5 watts
6	8 watts
8	2 strips 5 watts
12 to 14	2 strips 8 watts

2.3 CONTROLS

- A. Outdoor Thermostat: Remote bulb unit with adjustable temperature range from 0 to 120 deg F snap-action; open-on-rise, single-pole switch with 25-A rating. Set at 40°F.
- A. Cable Installation Accessories: Tapes, cable ties, warning labels, end seals and splices, and installation clips.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive heating cables for compliance with requirements for installation, tolerances, and other conditions affecting performance.
 - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
 - 2. Ensure pipe testing is complete.
 - 3. Ensure surfaces and substrates are level and plumb.
- B. Test cables for electrical continuity before installing.
- C. Test cables for insulation resistance before installing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Cut cable to length required.
- B. Install heater-to-cold lead connections in accessible locations. Do not embed in concrete or plaster.

3.3 CONNECTIONS

- A. Connect heating cables and other components to wiring systems.
- B. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform tests after installation but before application of coverings, such as insulation, plaster, or concrete.
 - 1. Test cables for electrical continuity before energizing.
 - 2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation.
- C. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.5 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.6 PROTECTION

- A. Protect installed heating cables, including leads, from damage before Substantial Completion.

END OF SECTION 230533

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING DUCTS AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.

1.2 SUMMARY

- A. This Section includes mechanical identification materials and devices.

1.3 SUBMITTALS

- A. Product Data: For identification materials and devices.
- B. Samples: Of color, lettering style, and graphic representation required for each identification material and device.
- C. Valve Schedules: For each piping system. Reproduce on standard-size bond paper. Tabulate valve number, piping system, system abbreviation as shown on tag, room or space location of valve, and variations for identification. Mark valves intended for emergency shutoff and similar special uses.

1.4 QUALITY ASSURANCE

- A. Comply with ASME A13.1, "Scheme for the Identification of Piping Systems" for lettering size, length of color field, colors, and viewing angles of identification devices.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 IDENTIFYING DEVICES AND LABELS

- A. General: Products specified are for applications referenced in other Division 23 Sections. If more than single type is specified for listed applications, selection is Installer's option.
- B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
 - 1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
 - 2. Location: Accessible and visible.
- C. Stencils: Standard stencils, prepared with letter sizes conforming to recommendations of ASME A13.1. Minimum letter height is 1-1/4 inches for ducts, and 3/4 inch for access door signs and similar operational instructions.
 - 1. Material: Fiberboard.
 - 2. Stencil Paint: Exterior, oil-based, alkyd gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.
- D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive, vinyl type with permanent adhesive.
- E. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.
- F. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers, at least 3 times letter height and of length required for label.
- G. Lettering: Manufacturer's standard preprinted captions as selected by Engineer.
- H. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 - 1. Arrows: Either integrally with piping system service lettering, to accommodate both directions, or as separate unit, on each pipe marker to indicate direction of flow.
- I. Plastic Duct Markers: Manufacturer's standard laminated plastic, in the following color codes:
 - 1. Green: Cold-air supply.
 - 2. Yellow: Hot-air supply.
 - 3. Blue: Exhaust, outside, return, and mixed air.

4. Hazardous Material Exhausts: Use colors and designs recommended by ASME A13.1.
 5. Terminology: Include direction of airflow; duct service such as supply, return, and exhaust; duct origin, duct destination, and design flow.
- J. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive, vinyl tape, at least 3 mils thick.
1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
 2. Color: Comply with ASME A13.1, unless otherwise indicated.
- K. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.
1. Material: 0.032-inch- thick, polished brass.
 2. Size: 1-1/2-inches diameter, unless otherwise indicated.
 3. Shape: As indicated for each piping system.
- L. Valve Tag Fasteners: Brass, wire-link chain; beaded chain; or S-hooks.
- M. Access Panel Markers: 1/16-inch- thick, engraved plastic-laminate markers, with abbreviated terms and numbers corresponding to concealed valve. Provide 1/8-inch center hole for attachment.
- N. Valve Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include screws.
1. Frame: Finished hardwood.
 2. Glazing: ASTM C 1036, Type I, Class 1, Glazing quality B, 2.5-mm, single-thickness glass.
- O. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
1. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
 2. Thickness: 1/8 inch, unless otherwise indicated.
 3. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.
- P. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:
1. Green: Cooling equipment and components.
 2. Yellow: Heating equipment and components.
 3. Brown: Energy reclamation equipment and components.
 4. Blue: Equipment and components that do not meet criteria above.
 5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
 6. Terminology: Match schedules as closely as possible. Include the following:

- a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
7. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.
- Q. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.
 1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

PART 3 - EXECUTION

3.1 LABELING AND IDENTIFYING PIPING SYSTEMS

- A. Install pipe markers on each system. Include arrows showing normal direction of flow.
- B. Marker Type: Stenciled markers with painted, color-coded bands or rectangles.
- C. Fasten markers on pipes and insulated pipes smaller than 6 inches OD by one of following methods:
 1. Snap-on application of pretensioned, semirigid plastic pipe marker.
 2. Adhesive lap joint in pipe marker overlap.
 3. Laminated or bonded application of pipe marker to pipe or insulation.
 4. Taped to pipe or insulation with color-coded plastic adhesive tape, not less than 3/4 inch wide, lapped a minimum of 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
- D. Fasten markers on pipes and insulated pipes 6 inches in diameter and larger by one of following methods:
 1. Laminated or bonded application of pipe marker to pipe or insulation.
 2. Taped to pipe or insulation with color-coded plastic adhesive tape, not less than 1-1/2 inches wide, lapped a minimum of 3 inches at both ends of pipe marker, and covering full circumference of pipe.
 3. Strapped to pipe or insulation with manufacturer's standard stainless-steel bands.
- E. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations according to the following:
 1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, where flow pattern is not obvious.
3. Near penetrations through walls, floors, ceilings, or nonaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at a maximum of 50-foot intervals along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

3.2 VALVE TAGS

- A. Install on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in valve schedule.
- B. Valve Tag Application Schedule: Tag valves according to size, shape, color scheme, and with captions similar to those indicated in the following:
- C. Tag Material: Brass.
- D. Tag Size and Shape: According to the following:
 1. Cold Water: 1-1/2 inches, round.
 2. Hot Water: 1-1/2 inches, round.
 3. Gas: 1-1/2 inches, round.
 4. Steam: 1-1/2 inches, round.
- E. Letter Color: According to the following:
 1. Cold Water: Black.
 2. Hot Water: Black.
 3. Gas: Black.
 4. Steam: Black.
- F. Install mounted valve schedule in each major equipment room.

3.3 EQUIPMENT SIGNS AND MARKERS

- A. Install engraved plastic-laminate signs or equipment markers on or near each major item of mechanical equipment. Include signs for the following general categories of equipment:
 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 2. Meters, gages, thermometers, and similar units.
 3. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.

4. Pumps, compressors, chillers, condensers, and similar motor-driven units.
 5. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
 6. Fans, blowers, primary balancing dampers, and mixing boxes.
 7. Packaged HVAC central-station and zone-type units.
 8. Tanks and pressure vessels.
 9. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.
- B. Optional Sign Types: Stenciled signs may be provided instead of engraved plastic, at Installer's option, where lettering larger than 1-inch high is needed for proper identification because of distance from normal location of required identification.
1. Lettering Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 2. Terms on Signs: Distinguish between multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
- C. Plasticized Tags: Install within concealed space, to reduce amount of text in exposed sign outside concealment, if equipment to be identified is concealed above acoustical ceiling or similar concealment.
1. Identify operational valves and similar minor equipment items located in unoccupied spaces, including machine rooms, by installing plasticized tags.
- D. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers; or provide stenciled signs and arrows showing service and direction of flow.
1. Location: Locate signs near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.
- 3.4 ADJUSTING AND CLEANING
- A. Relocate mechanical identification materials and devices that have become visually blocked by work of this or other Divisions.
 - B. Clean faces of identification devices and glass frames of valve charts.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:
 - 1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
 - 2. Adjusting total HVAC systems to provide indicated quantities.
 - 3. Measuring electrical performance of HVAC equipment.
 - 4. Setting quantitative performance of HVAC equipment.
 - 5. Verifying that automatic control devices are functioning properly.
 - 6. Reporting results of the activities and procedures specified in this Section.

1.2 SUBMITTALS

- A. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.
- B. Certified Testing, Adjusting, and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.
- C. Sample Report Forms: Submit 2 sets of sample testing, adjusting, and balancing report forms.

1.3 QUALITY ASSURANCE

- A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.
- B. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
- C. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing."

- D. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards.

1.4 COORDINATION

- A. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine Architect's and Engineer's design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- D. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

3.2 GENERAL TESTING AND BALANCING PROCEDURES

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.
- C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.3 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of the instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to the certified field report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.
- D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of testing, adjusting, and balancing Agent.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of testing, adjusting, and balancing Agent who certifies the report.
 - 10. Summary of contents, including the following:
 - a. Design versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 11. Nomenclature sheets for each item of equipment.
 - 12. Data for terminal units, including manufacturer, type size, and fittings.
 - 13. Notes to explain why certain final data in the body of reports vary from design values.
 - 14. Test conditions for fans and pump performance forms, including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.

- e. Fan drive settings, including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:
 - 1. Quantities of outside, supply, return, and exhaust airflows.
 - 2. Water and steam flow rates.
 - 3. Duct, outlet, and inlet sizes.
 - 4. Pipe and valve sizes and locations.
 - 5. Terminal units.
 - 6. Balancing stations.
- F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
 - 1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Number of belts, make, and size.
 - i. Number of filters, type, and size.
 - j. Motor make and frame type and size.
 - k. Horsepower and rpm.
 - l. Volts, phase, and hertz.
 - m. Full-load amperage and service factor.
 - n. Sheave make, size in inches, and bore.
 - o. Sheave dimensions, center-to-center and amount of adjustments in inches.
 - p. Total airflow rate in cfm.
 - q. Total system static pressure in inches wg.
 - r. Fan rpm.
 - s. Discharge static pressure in inches wg.
 - t. Filter static-pressure differential in inches wg.
 - u. Cooling coil static-pressure differential in inches wg.
 - v. Heating coil static-pressure differential in inches wg.
 - w. Outside airflow in cfm.
 - x. Return airflow in cfm.
 - y. Outside-air damper position.
 - z. Return-air damper position.
 - aa. Vortex damper position.
- G. Apparatus-Coil Test Reports: For apparatus coils, include the following:
 - 1. Coil Data: Include the following:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch.
- f. Make and model number.
- g. Face area in sq. ft..
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.
- k. Airflow rate in cfm.
- l. Average face velocity in fpm.
- m. Air pressure drop in inches wg.
- n. Outside-air, wet- and dry-bulb temperatures in deg F.
- o. Return-air, wet- and dry-bulb temperatures in deg F.
- p. Entering-air, wet- and dry-bulb temperatures in deg F.
- q. Leaving-air, wet- and dry-bulb temperatures in deg F.
- r. Water flow rate in gpm.
- s. Water pressure differential in feet of head or psig.
- t. Entering-water temperature in deg F.
- u. Leaving-water temperature in deg F.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data: Include the following:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and size.
- e. Manufacturer's serial number.
- f. Arrangement and class.
- g. Motor make and frame type and size.
- h. Horsepower and rpm.
- i. Volts, phase, and hertz.
- j. Full-load amperage and service factor.
- k. Sheave make, size in inches, and bore.
- l. Sheave dimensions, center-to-center and amount of adjustments in inches.
- m. Number of belts, make, and size.
- n. Total airflow rate in cfm.
- o. Total system static pressure in inches wg.
- p. Fan rpm.
- q. Discharge static pressure in inches wg.
- r. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data: Include the following:

- a. System and air-handling unit number.

- b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Design airflow rate in cfm.
 - h. Design velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
- J. Air-Terminal-Device Reports: For terminal units, include the following:
- 1. Unit Data: Include the following:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Test apparatus used.
 - d. Area served.
 - e. Air-terminal-device make.
 - f. Air-terminal-device number from system diagram.
 - g. Air-terminal-device type and model number.
 - h. Air-terminal-device size.
 - i. Airflow rate in cfm.
 - j. Air velocity in fpm.
 - k. Preliminary airflow rate as needed in cfm.
 - l. Preliminary velocity as needed in fpm.
 - m. Final airflow rate in cfm.
 - n. Final velocity in fpm.
 - o. Space temperature in deg F.
- K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
- 1. Unit Data: Include the following:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 - f. Airflow rate in cfm.
 - g. Entering-water temperature in deg F.
 - h. Leaving-water temperature in deg F.
 - i. Water pressure drop in feet of head or psig.
 - j. Entering-air temperature in deg F.
 - k. Leaving-air temperature in deg F.
- L. Pump Test Reports: For pumps, include the following data. Calculate impeller size by plotting the shutoff head on pump curves.
- 1. Unit Data: Include the following:

- a. Unit identification.
- b. Location.
- c. Service.
- d. Make and size.
- e. Model and serial numbers.
- f. Water flow rate in gpm.
- g. Water pressure differential in feet of head or psig.
- h. Required net positive suction head in feet of head or psig.
- i. Pump rpm.
- j. Impeller diameter in inches.
- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

M. Packaged Chiller Reports: For each chiller, include the following:

1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Make and model number.
 - c. Manufacturer's serial number.
 - d. Entering-water temperature in deg F.
 - e. Leaving-water temperature in deg F.
 - f. Entering-water pressure in feet of head or psig.
 - g. Water pressure differential in feet of head or psig.
 - h. Voltage at each connection.
 - i. Amperage for each phase.
 - j. Chilled water control set point in deg F.

N. Boiler Test Reports: For boilers, include the following:

1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and type.
 - e. Model and serial numbers.
 - f. Fuel type and input in Btuh
 - g. Ignition type.
 - h. Burner-control types.
 - i. Voltage at each connection.
 - j. Amperage for each phase.
 - k. Operating pressure in psig.
 - l. Operating temperature in deg F.
 - m. Entering-water temperature in deg F.
 - n. Leaving-water temperature in deg F.
 - o. Number of safety valves and sizes in NPS.

- O. Instrument Calibration Reports: For instrument calibration, include the following:
 - 1. Report Data: Include the following:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

END OF SECTION 230593

SECTION 230700 - HVAC DUCT INSULATION

PART 1 - GENERAL

- A. This Section includes semirigid and flexible duct, and plenum insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.2 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for the following:
 - 1. Removable insulation sections at access panels.
 - 2. Application of field-applied jackets.
 - 3. Applications at linkages for control devices.

1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin, .75 lbs. per cubic foot density, thermal conductivity (K value) no more than .29. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.
- B. Mineral-Fiber Board (Rigid) Thermal Insulation: Glass fibers bonded with a thermosetting resin, 3.0 lbs. per cubic foot density, thermal conductivity (K value) no more than .23. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.
- C. Internal duct lining shall not be used.

2.2 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.

- B. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd..
- C. Canvas Cloth : Woven canvas fabrics, plain weave, presized a minimum of 8 oz./sq. yd.
- D. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
- E. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
 - 1. Adhesive: As recommended by insulation material manufacturer.
 - 2. PVC Jacket Color: White.
- F. Aluminum Jacket: .032" thick, deep corrugated sheets manufactured from aluminum alloy complying with ASTM B 209, and having an integrally bonded moisture barrier over entire surface in contact with insulation. Metal thickness and corrugation dimensions are scheduled at the end of this Section.
 - 1. Finish: Stucco embossed finish.
 - 2. Moisture Barrier: 1-mil- thick, heat-bonded polyethylene and kraft paper.

2.3 VAPOR RETARDERS

- A. Aluminum foil reinforced with fiberglass scrim laminated to UL rated kraft. Permeance shall not exceed .02 perms.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
- B. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
- C. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

- D. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- E. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.

3.3 MINERAL-FIBER INSULATION APPLICATION

- A. Blanket Applications for Ducts and Plenums: Secure insulation with adhesive and anchor pins and speed washers. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch- wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins.

3.4 FIELD-APPLIED JACKET APPLICATION

- A. Apply glass-cloth or canvas cloth jacket, where indicated, directly over insulation vapor barrier.

3.5 DUCT SYSTEM APPLICATIONS

- A. Materials and thicknesses for systems listed below shall comply with the requirements of the North Carolina State Energy Code and shall be not less than the "R" values specified in schedules at the end of this Section.
- B. Insulate the following plenums and duct systems:
 - 1. Indoor concealed supply and outside-air ductwork.
 - 2. Indoor exposed supply and outside-air ductwork.
 - 3. Indoor concealed and exposed return air duct located in non conditioned spaces such as Mechanical Equipment Rooms and ventilated attics.
 - 4. Outdoor exposed supply and return and outside air ductwork.

3.6 INDOOR DUCT AND PLENUM APPLICATION SCHEDULE

- A. Service: Round, supply-air ducts, concealed. (Return air ducts located in non conditioned spaces)
 - 1. Material: **Mineral-fiber blanket**
 - 2. Thickness: **Apx. 2.25 inches (minimum R value 6.0)**
 - 3. Number of Layers: **One**
 - 4. Field-Applied Jacket: **Foil and paper.**
 - 5. Vapor Retarder Required: **Yes.**

- B. Service: Round, outside-air ducts, concealed. (Return air ducts located in non conditioned spaces)
 - 1. Material: **Mineral-fiber blanket**
 - 2. Thickness: **Apx. 2.25 inches (minimum R value 6.0)**
 - 3. Number of Layers: **One**
 - 4. Field-Applied Jacket: **Foil and paper.**
 - 5. Vapor Retarder Required: **Yes.**
- C. Service: Rectangular, supply-air ducts, concealed. (Return air ducts located in non conditioned spaces)
 - 1. Material: **Mineral-fiber blanket**
 - 2. Thickness: **Apx. 2.25 inches (minimum R value 6.0)**
 - 3. Number of Layers: **One**
 - 4. Field-Applied Jacket: **Foil and paper.**
 - 5. Vapor Retarder Required: **Yes.**
- D. Service: Rectangular, outside-air ducts, concealed.
 - 1. Material: **Mineral-fiber blanket**
 - 2. Thickness: **Apx. 2.25 inches (minimum R value 6.0)**
 - 3. Number of Layers: **One**
 - 4. Field-Applied Jacket: **Foil and paper.**
 - 5. Vapor Retarder Required: **Yes.**
- E. Service: Round, supply-air ducts, exposed. (Return air ducts located in non conditioned spaces)
 - 1. Material: **Mineral-fiber blanket**
 - 2. Thickness: **Apx. 2.25 inches (minimum R value 6.0)**
 - 3. Number of Layers: **One**
 - 4. Field-Applied Jacket: **Canvas Cloth .**
 - 5. Vapor Retarder Required: **Yes.**
- F. Service: Round, outside-air ducts, exposed.

1. Material: **Mineral-fiber blanket**
 2. Thickness: **Apx. 2.25 inches (minimum R value 6.0)**
 3. Number of Layers: **One**
 4. Field-Applied Jacket: **Canvas Cloth**
 5. Vapor Retarder Required: **Yes.**
- G. Service: Rectangular, supply-air ducts, exposed. (Return air ducts located in non conditioned spaces)
1. Material: **Mineral-fiber board (rigid)**
 2. Thickness: **Apx. 2 inches (minimum R value 8.0)**
 3. Number of Layers: **One**
 4. Field-Applied Jacket: **Canvas Cloth.**
 5. Vapor Retarder Required: **Yes.**
- H. Service: Rectangular, outside-air ducts, exposed.
1. Material: **Mineral-fiber board (rigid)**
 2. Thickness: **Apx. 2 inches (minimum R value 8.0)**
 3. Number of Layers: **One**
 4. Field-Applied Jacket: **Canvas Cloth.**
 5. Vapor Retarder Required: **Yes.**

END OF SECTION 230700

SECTION 230705 – HVAC PIPE INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.
- B. Related Sections include the following:
 - 1. Division 23 Section "Duct Insulation" for insulation for ducts and plenums.
 - 2. Division 23 Section "Equipment Insulation" for insulation materials and application for pumps, tanks, hydronic specialties, and other equipment.
 - 3. Division 23 Section "Hangers and Supports" for pipe insulation shields and protection saddles.

1.2 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for the following:
 - 1. Application of protective shields, saddles, and inserts at pipe hangers for each type of insulation and hanger.
 - 2. Attachment and covering of heat trace inside insulation.
 - 3. Insulation application at pipe expansion joints for each type of insulation.
 - 4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Removable insulation at piping specialties and equipment connections.
 - 6. Application of field-applied jackets.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
 2. Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
 3. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
 - a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
 - b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
 4. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
 5. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
 6. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
 7. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
- B. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Polyethylene or Polymer insulations are not acceptable. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials. Insulation shall be AP/Armaflex or equal.
1. Adhesive: As recommended by insulation material manufacturer.
 2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.
- C. Polyisocyanurate Foam Insulation: Preformed polyurethane modified polyisocyanurate cellular pipe insulation of rigid, expanded, closed-cell structure. Density of 2.05 lbs per cubic foot, 75°F aged k-factor of .19, flame and smoke less than 25-50 in thicknesses 1.5" and less.
1. Adhesive: As recommended by insulation material manufacturer
 2. UV radiation protection coverings: As recommended by the insulation material manufacturer
- D. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.2 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.

- B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
- C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
 - 1. Adhesive: As recommended by insulation material manufacturer.
 - 2. PVC Jacket Color: Color-code piping jackets based on materials contained within the piping system.
- D. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC.
 - 1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 - 2. Adhesive: As recommended by insulation material manufacturer.
- E. Aluminum Jacket: Aluminum roll stock, ready for shop or field cutting and forming to indicated sizes. Comply with ASTM B 209, 3003 alloy, H-14 temper.
 - 1. Finish and Thickness: Stucco-embossed finish, 0.016 inch thick.
 - 2. Moisture Barrier: 1-mil- thick, heat-bonded polyethylene and kraft paper.
 - 3. Elbows: Preformed, 45- and 90-degree, short- and long-radius elbows; same material, finish, and thickness as jacket.
- F. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd..
- G. Canvas Cloth and Tape: Woven canvas-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd.

2.3 ACCESSORIES AND ATTACHMENTS

- A. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
 - 1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
 - 2. Galvanized Steel: 0.005 inch thick.
 - 3. Aluminum: 0.007 inch thick.
 - 4. Brass: 0.010 inch thick.
 - 5. Nickel-Copper Alloy: 0.005 inch thick.
- B. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

2.4 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.
- I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

- L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
 - 1. Apply insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
 - 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- O. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Circumferential Joints: Cover with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
 - 3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
 - 4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
 - 5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
- P. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
 - 1. Seal penetrations with vapor-retarder mastic.
 - 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 - 3. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal metal jacket to roof flashing with vapor-retarder mastic.
- Q. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.

- R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- S. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."
- T. Floor Penetrations: Apply insulation continuously through floor assembly.
 - 1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 MINERAL-FIBER INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
 - 1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
 - 2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.
 - 3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
 - 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to flanges as follows:
 - 1. Apply preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 - 4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.
- C. Apply insulation to fittings and elbows as follows:
 - 1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 - 2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
 - 3. Cover fittings with standard PVC fitting covers.
 - 4. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with

manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D. Apply insulation to valves and specialties as follows:

1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
3. Apply insulation to flanges as specified for flange insulation application.
4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
5. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
6. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 POLYISOCYANURATE INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of insulation to pipe with wire, tape, or bands without deforming insulation materials.
2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.
3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of the same thickness as pipe insulation.
4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:

1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded sections of insulation are not available, apply mitered sections of cellular-glass insulation. Secure insulation materials with wire, tape, or bands.
3. Cover fittings with standard PVC fitting covers.
4. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D. Apply insulation to valves and specialties as follows:

1. Apply premolded segments of cellular-glass insulation or glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
2. Apply insulation to flanges as specified for flange insulation application.
3. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
4. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.6 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Follow manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to flanges as follows:

1. Apply pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

C. Apply insulation to fittings and elbows as follows:

1. Apply mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

D. Apply insulation to valves and specialties as follows:

1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
2. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to stainer basket.
3. Apply insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.7 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.

1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of jacket manufacturer's recommended adhesive.
3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

B. Foil and Paper Jackets: Apply foil and paper jackets where indicated.

1. Draw jacket material smooth and tight.
2. Apply lap or joint strips with the same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Apply jackets with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.

C. Apply PVC jacket where indicated, with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

D. Apply metal jacket where indicated, with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.8 FINISHES

- A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Division 9 Section "Painting."
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Engineer. Vary first and second coats to allow visual inspection of the completed Work.

3.9 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 - 1. Flexible connectors.
 - 2. Vibration-control devices.
 - 3. Fire-suppression piping.
 - 4. Drainage piping located in crawl spaces, unless otherwise indicated.
 - 5. Below-grade piping, unless otherwise indicated.
 - 6. Chrome-plated pipes and fittings, unless potential for personnel injury.
 - 7. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.10 FIELD QUALITY CONTROL

- A. Inspection: Owner will engage a qualified inspection agency to perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:
- B. Inspection: Engage a qualified inspection agency to perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:
- C. Inspection: Perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:
 - 1. Inspect fittings and valves randomly selected by Engineer.
 - 2. Remove fitting covers from 20 elbows or 1 percent of elbows, whichever is less, for various pipe sizes.
 - 3. Remove fitting covers from 20 valves or 1 percent of valves, whichever is less, for various pipe sizes.
- D. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.
- E. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.11 INSULATION APPLICATION SCHEDULE, GENERAL

- A. Materials and thicknesses for systems listed below shall comply with the requirements of the North Carolina State Energy Code and shall be not less than the "thicknesses specified below.

3.12 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Domestic cold water.

1. Operating Temperature: 45 to 80 deg F.
2. Insulation Material: **Mineral fiber**
3. Insulation Thickness:
Pipe size 1" I.P.S. and below..... 1/2"
Pipe size 1 1/4" to 2" 1"
Pipe size 2 1/2" to 6" 1"
4. Field-Applied Jacket: **PVC for exposed areas Foil and Paper (ASJ) concealed areas.**
5. Vapor Retarder Required: **Yes**

- B. Service: Refrigerant suction piping.

1. Operating Temperature: 35 to 75 deg F.
2. Insulation Material: **Flexible elastomeric.**
3. Insulation Thickness: 3/4"
4. Field-Applied Jacket: None. (UV protection coating for exterior piping)
5. Vapor Retarder Required: **Yes.**

- C. Service: Condensate drain piping.

1. Operating Temperature: 35 to 75 deg F.
2. Insulation Material: **Flexible elastomeric.**
3. Insulation Thickness: 3/4"
4. Field-Applied Jacket: None.
5. Vapor Retarder Required: **Yes.**

- D. Service: Chilled-water supply and return.

1. Operating Temperature: 35 to 75 deg F.
2. Insulation Material: **Polyisocyanurate**
3. Insulation Thickness: Apply the following insulation thicknesses:
Runouts less than 12' long up to and including 2"..... 1"
Pipe size 4" and below..... 1"
Pipe size 5" and larger..... 1 1/2"
4. Field-Applied Jacket: **PVC for exposed areas Foil and Paper (ASJ) concealed areas.**
5. Vapor Retarder Required: **Yes**

- E. Service: Heating hot-water supply and return.

1. Operating Temperature: 100 to 200 deg F.
2. Insulation Material: **Mineral fiber.**
3. Insulation Thickness: Apply the following insulation thicknesses:
Runouts less than 12' long up to and including 2" I.P.S..... 1 1/2"
Pipe size 2" and below..... 1"
Pipe size 2-1/2" and larger..... 1 1/2"
4. Field-Applied Jacket: Field-Applied Jacket: **PVC for exposed areas Foil and Paper (ASJ) concealed areas.**
5. Vapor Retarder Required: **No.**

3.13 EXTERIOR INSULATION APPLICATION SCHEDULE

A. This application schedule is for aboveground insulation outside the building.

1. Piping shall be insulated same as interior piping plus with an aluminum weatherproof jacket.

B. Service: Chilled water supply and return exposed outside of the building.

1. Operating Temperature: 35 to 95 deg F.
2. Insulation Material: **Polyisocyanurate**
3. Insulation Thickness: Apply the following insulation thicknesses:
Pipe size 2" and below..... 3/4"
Pipe size 2 1/2" and greater..... 1"
4. Field-Applied Jacket: **Aluminum**
5. Vapor Retarder Required: **Yes**
6. Apply self limiting heat tape with an ambient thermostat to prevent pipe from freezing in 0°F ambient temperatures.

END OF SECTION 230705

SECTION 230707 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes blanket, board, and block insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.2 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for the following:
 - 1. Field application for each equipment type.
 - 2. Removable insulation sections at access panels.
 - 3. Application of field-applied jackets.

1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.
- B. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

- C. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
 - 1. Adhesive: As recommended by insulation material manufacturer.
 - 2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

2.2 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
- C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
 - 1. Adhesive: As recommended by insulation material manufacturer.
 - 2. PVC Jacket Color: Color-code to match connected piping jackets based on materials contained within the piping system.

2.3 ACCESSORIES AND ATTACHMENTS

- A. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
 - 1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
 - 2. Galvanized Steel: 0.005 inch thick.
 - 3. Aluminum: 0.007 inch thick.
 - 4. Brass: 0.010 inch thick.
 - 5. Nickel-Copper Alloy: 0.005 inch thick.
- B. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.
- C. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.
 - 1. Welded Pin Holding Capacity: 100 lb for direct pull perpendicular to the attached surface.

2.4 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of equipment.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each equipment system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either the wet or dry state.
- D. Apply multiple layers of insulation with longitudinal and end seams staggered.
- E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- F. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- G. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
- H. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- I. Install vapor-retarder mastic on equipment scheduled to receive vapor retarders. Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
- J. Insulate the following indoor equipment:

1. Chilled-water centrifugal pump housings.
2. Heating hot-water centrifugal pump housings

K. Omit insulation from the following:

1. Testing agency labels and stamps.
2. Nameplates and data plates.
3. Manholes.
4. Handholes.
5. Cleanouts.

3.4 INDOOR TANK AND VESSEL INSULATION APPLICATION

A. Blankets, Board, and Block Applications for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to the equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joint. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Secure each layer of insulation with stainless-steel bands.
5. Stagger joints between insulation layers at least 3 inches.
6. Apply insulation in removable segments on equipment access doors and other elements that require frequent removal for service.
7. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

B. Flexible Elastomeric Thermal Insulation Applications for Tanks and Vessels: Apply insulation over entire surface of tanks and vessels according to the manufacturer's written instructions.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

3.5 FIELD-APPLIED JACKET APPLICATION

A. PVC Jackets: Apply jacket with longitudinal seams along top and bottom of tanks and vessels for horizontal applications. Secure and seal seams and end joints with manufacturer's welding adhesive.

3.6 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.7 EQUIPMENT APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

3.8 INTERIOR TANK AND VESSEL INSULATION APPLICATION SCHEDULE

- A. Equipment: Chilled-water air separators and centrifugal pump housing, Chillers not factory insulated. Pump housing shall be equipped with a removable galvanized sheet metal cover to permit access for servicing.

- 1. Operating Temperature: 35 to 75 deg F.
- 2. Insulation Material: **Flexible Elastomeric Thermal Insulation**
- 3. Insulation Thickness: 1"
- 4. Field-Applied Jacket: PVC.
- 5. Vapor Retarder Required: **Yes**.

- B. Equipment: Heating hot-water air separators, and centrifugal pumps.

- 1. Operating Temperature: 100 to 200 deg F.
- 2. Insulation Material: **Mineral fiber**
- 3. Insulation Thickness: 1 ½"
- 4. Field-Applied Jacket: PVC.
- 5. Vapor Retarder Required: **No**.

END OF SECTION 230707

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. The system shall be a DDC "web based" open protocol Building Automation and Control System.
- C. The system Ethernet interface allows those with the correct password the ability to control the facility from any remote location or from within the same facility as long as they have system Ethernet connectivity. The software is a standard Internet browser such as Microsoft Internet Explorer. System must be capable of unlimited simultaneous users. Systems that are not unlimited or require seat licensing and/or adding additional server hardware are not allowed.
- D. Provide VAV operators to the VAV Terminal manufacturer for mounting in the factory.
- E. SYSTEM FEATURES AND ARCHITECTURE
 - 1. The controls system shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management and historical data collection.
 - 2. System shall be an open protocol "web based system" accessible via the internet by authorized users.
 - 3. System shall be "web based" and utilize open protocol architecture such as Tritium R2 with open protocol communication such as LonWorks, BACnet, Modbus, etc.
 - 4. System shall be configured as a distributed processing network of direct digital control (DDC) panels. The system shall be completely modular and stand-alone in both hardware and software and allow for expansion in both function and capacity. Systems requiring a host computer processor for any of the system control operations shall not be acceptable.
 - 5. System graphics shall include dynamic color screens displaying building and HVAC system diagrams with real time values.

1.2 DEFINITIONS

- A. DDC: Direct-digital controls.

- B. LAN: Local area network.
- C. MS/TP: Master-slave/token-passing.
- D. PICS: Protocol Implementation Conformance Statement.

1.3 SYSTEM DESCRIPTION

- A. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
- B. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems.

1.4 SEQUENCE OF OPERATION

- A. Sequence of Operation is shown on the drawings.

1.5 SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 1. Each control device labeled with setting or adjustable range of control.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 - 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - 3. Details of control panel faces, including controls, instruments, and labeling.
 - 4. Written description of sequence of operation.
 - 5. Schedule of dampers including size, leakage, and flow characteristics.
 - 6. Schedule of valves including leakage and flow characteristics.
 - 7. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
 - 8. Listing of connected data points, including connected control unit and input device.
 - 9. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
 - 10. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

- C. ASHRAE BACnet Statement: PICS for each DDC system component (panel, zone controller, field devices, and operator workstation) proposed.
 - D. Samples: For each color required, of each type of thermostat cover.
 - E. Software and Firmware Operational Documentation: Include the following:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
 - 5. Software license required by and installed for DDC workstations and control systems.
 - F. Software Upgrade Kit: For Owner to use in modifying software to suit future power system revisions or monitoring and control revisions.
 - G. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
 - H. Maintenance Data: For systems to include in maintenance manuals specified in Division 1. Include the following:
 - 1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 - 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 - 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 5. Calibration records and list of set points.
 - I. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
 - J. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.
- 1.6 QUALITY ASSURANCE
- A. Installer Qualifications: An experienced installer who is **a factory authorized representative** of the automatic control system manufacturer for both installation and maintenance of units required for this Project.
 - B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."
- E. Comply with ASHRAE 135 for DDC system control components.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

PART 2 - PRODUCTS

2.1 DDC EQUIPMENT

- A. Operator Station: Microcomputer station with printer.
- B. Workstation: IBM-compatible microcomputer with minimum configuration as follows:
 - 1. Processor: Intel Core 2 Duo Processor 3.0 GHz.
 - 2. Random-Access Memory: 3 GB
 - 3. Graphics: ATI Radeon HD 2400 XT 256-MB EDO video memory.
 - 4. Monitor: 20 inches, wide screen, flat panel.
 - 5. Keyboard: QWERTY, 105 keys in ergonomic shape.
 - 6. Hard-Disk Drive: 250.0 GB.
 - 7. Mouse: Three button.
 - 8. Operating System: Microsoft Windows XP.
 - 9. BACnet Conformance: Workstation shall support BACnet device and have minimum capabilities defined in PICS for the following areas:
 - a. Network.
 - b. Functional groups.
 - c. Standard application services supported.
 - d. Standard objects supported.
- C. Printer: Color, ink-jet type:
- D. Application Software: Include the following:
 - 1. Input/output capability from operator station.
 - 2. Operator system access levels via software password.
 - 3. Database creation and support.
 - 4. Dynamic color graphic displays.
 - 5. Alarm processing.
 - 6. Event processing.
 - 7. Automatic restart of field equipment on restoration of power.

8. Data collection.
 9. Graphic development on workstation.
 10. Maintenance management.
- E. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
1. Units monitor or control each input/output point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator station.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse input/output.
 - c. Monitoring, controlling, or addressing data points.
 - d. Testing and developing control algorithms without disrupting field hardware and controlled environment.
 3. Local operator interface provides for download from or upload to mobile operator station.
 4. BACnet Conformance: Reside on BACnet LAN in Ethernet IEEE 802.3, Class 3, minimum, with routers between LAN and other panels, with at least one communication port, and have minimum capabilities defined in PICS for the following areas:
 - a. Network.
 - b. Functional groups.
 - c. Standard application services supported.
 - d. Standard objects supported.
- F. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
1. Units monitor or control each input/output point; process information; and download from or upload to operator station.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse input/output.
 - c. Monitoring, controlling, or addressing data points.
 3. Local operator interface provides for download from or upload to mobile operator station.
 4. BACnet Conformance: Reside on BACnet LAN using MS/TP, Class 2, minimum, with at least one communication port, and have minimum capabilities defined in PICS for the following areas:
 - a. Network.
 - b. Functional groups.

- c. Standard application services supported.
 - d. Standard objects supported.
- G. Software: Update to latest version of software at Project completion. Include and implement the following capabilities from the control units:
 - 1. Units of Measure: Inch-pound and SI (metric).
 - 2. Load Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, DDC with fine tuning, and trend logging.
 - 3. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
 - 4. Chiller Control Programs: Control function of condenser water reset, chilled-water reset, and equipment sequencing.
 - 5. Programming Application Features: Include trend point, alarm messages, weekly scheduling, and interlocking.

2.2 CONTROL PANELS

- A. Central (Master) Control Panels: Fully enclosed, steel-rack-type cabinet with locking doors or locking removable backs. Match finish of panels and provide multicolor graphic displays, schematically showing system being controlled.
- B. Local Control Panels: Unitized cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.
 - 1. Fabricate panels of furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
 - 2. Panel-Mounted Equipment: Temperature and humidity controllers, relays, and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.
 - 3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
 - 4. Graphics: Color-coded graphic, laminated-plastic displays on doors, schematically showing system being controlled, with protective, clear plastic sheet bonded to entire door.
- C. Alarm Panels: Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted in hinged-cover enclosure.
 - 1. Alarm Condition: Indicating light flashes and horn sounds.
 - 2. Acknowledge Switch: Horn is silent and indicating light is steady.
 - 3. Second Alarm: Horn sounds and indicating light is steady.
 - 4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
 - 5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.3 ANALOG CONTROLLERS

- A. Step Controllers: Six- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.
- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
 - 1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
- D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.
- E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
 - 1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.
 - 2. Proportional band shall extend from 2 to 20 percent for 5 psig.
 - 3. Authority shall be 20 to 200 percent.
 - 4. Air-supply pressure of 18 psig, input signal of 3 to 15 psig, and output signal 0 to supply pressure.
 - 5. Gages: 2-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.4 TIME CLOCKS

- A. Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.
- B. Solid-state, programmable time control with 4 separate programs; 24-hour battery carryover; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; and system fault alarm.

2.5 SENSORS

- A. Electronic Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
1. Thermistor temperature sensors as follows:
 - a. Accuracy: Plus or minus **0.5 deg F** at calibration point.
 - b. Wire: Twisted, shielded-pair cable.
 - c. Insertion Elements in Ducts: Single point, use where not affected by temperature stratification or where ducts are smaller than **9 sq. ft.**.
 - d. Averaging Elements in Ducts: use where prone to temperature stratification or where ducts are larger than **9 sq. ft.**; length as required.
 - e. Insertion Elements for Liquids: Brass socket with minimum insertion length of **2-1/2 inches**.
 - f. Room Sensors: Match room thermostats, locking cover.
 - g. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 2. Resistance Temperature Detectors: Platinum.
 - a. Accuracy: Plus or minus 0.2 percent at calibration point.
 - b. Wire: Twisted, shielded-pair cable.
 - c. Insertion Elements in Ducts: Single point, long; use where not affected by temperature stratification or where ducts are smaller than **9 sq. ft.**.
 - d. Averaging Elements in Ducts: use where prone to temperature stratification or where ducts are larger than **9 sq. ft.**; length as required.
 - e. Insertion Elements for Liquids: Brass socket with minimum insertion length of **2-1/2 inches**.
 - f. Room Sensors: Match room thermostats, locking cover.
 - g. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 3. Humidity Sensors: Bulk polymer sensor element.
 - a. Accuracy: 5 percent full range with linear output.
 - b. Room Sensors: With locking cover matching room thermostats, span of 25 to 90 percent relative humidity.
 - c. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
 4. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.
 - c. Building Static-Pressure Range: **0 to 0.10inch wg.**
 - d. Duct Static-Pressure Range: **0 to 5 inches wg.**
 5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.
- B. Equipment operation sensors as follows:
1. Status Inputs for Fans: Differential-pressure switch with adjustable range.

2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range.
 3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- C. Digital-to-Pneumatic Transducers: Convert plus or minus 12-V dc pulse-width-modulation outputs, or continuous proportional current or voltage to **0 to 20 psig**.
- D. Pneumatic Valve/Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank-arm assembly connected to damper to transmit 0 to 100 percent valve/damper travel.
- E. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- F. Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle. For chilled-water applications, provide vaporproof type.
- G. Carbon-Monoxide Detectors: Single or multichannel, dual-level detectors, using solid-state sensors with 3-year minimum life, maximum 15-minute sensor replacement, suitable over a temperature range of **23 to 130 deg F**, calibrated for 50 and 100 ppm, with maximum 120-second response time to 100-ppm carbon monoxide.
- H. Carbon-Dioxide Sensor and Transmitter: Single detectors, using solid-state infrared sensors, suitable over a temperature range of **23 to 130 deg F**, calibrated for 0 to 2 percent, with continuous or averaged reading, 4 to 20 mA output, and wall mounted.
- I. Oxygen Sensor and Transmitter: Single detectors, using solid-state zircon cell sensing, suitable over a temperature range of **minus 32 to plus 1100 deg F**, calibrated for 0 to 5 percent, with continuous or averaged reading, 4 to 20 mA output, and wall mounted.
- J. Refrigerant Detectors: Dual-level detectors, using solid-state sensors, with alarm preset for 300 ppm, alarm indicator light, alarm silence light and button, alarm test light and button, and trouble light. Provide auxiliary relay preset for 150 ppm.
- K. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment, for flush mounting.
- L. Temperature Sensors: The following shall apply to temperature sensors:
1. Stem or tip sensitive types
 2. Sensing elements shall be hermetically sealed. Stem and tip construction shall be 304 stainless steel.
 4. All external trim material shall be corrosion resistant designed for the intended application.
 5. Thermometer wells shall be stainless steel. Heat transfer compounds shall be compatible with the sensors
 6. Space temperature sensors in administration areas must have adjustable set-point slider.
- M. PRESSURE

1. Air pressure transmitter shall universally measure very low static or differential pressure using a variable capacitance technique. Static pressure shall measure in ranges from 0 to 10 inches water column. Differential air pressure shall have a range of 0 to +/-0.5 inches. Transmitter accuracy, including non-linearity, hysteresis and non-repeatability shall be within 1% of full scale.
2. Dirty Filter Indication: Dirty filter shall be indicated as an alarm. Sensor shall be Dwyer 1823-0 or 1823-1 which ever is required

N. POWER METERING

1. Electrical demand shall be from pulsing dry contacts provided by owner and installed by the Utility Company at the power meter. The DDC system shall be capable of measuring and scaling any pulse rate provided by the utility company.

O. SURGE AND LIGHTNING PROTECTION

1. Line voltage protection: The CU's shall be powered by 120 VAC circuits provided with surge protection. This protection is in addition to any internal protection provided by the manufacturer. The protection shall be a LA302RUL manufactured by Delta Lightning Arresters Inc. or an approved equal. For all DCP locations with telephone modem, an MP11 (as manufactured by GSI or equal) shall be used to provide AC line and telephone line protection. A grounding conductor, (minimum 12 awg), shall be brought to each control panel from either a driven ground rod or the ground bus in a breaker panel. Conduit grounds will not be acceptable.

2.6 THERMOSTATS

- A. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater.
- B. Space Thermostats
 1. All room thermostats in classrooms and offices shall have exposed setpoint adjustment with software stops (adjustable through the BAS) for minimum and maximum setting. Limit stops shall be controlled by the BAS and shall initially set between 68 degrees and 75 degrees. Thermostats shall have timed override function.
 2. All room thermostats in public areas will have concealed setpoint adjustments with blank cover.
 3. Insulated mounting bases on exterior walls
 4. Accuracy to +/-0.5%
- C. Each thermostat shall be capable of reporting the space temperature and setpoint. In addition, each shall be capable of remote reset by the DDC system
- D. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater.
- E. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual on-off-auto selector switch.

- F. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature, with copper capillary and bulb, unless otherwise indicated.
 - 1. Bulbs in water lines with separate wells of same material as bulb.
 - 2. Bulbs in air ducts with flanges and shields.
 - 3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit, adequately supported.
 - 4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
 - 5. On-Off Thermostat: With precision snap switches, with electrical ratings required by application.
 - 6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- G. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- H. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type, with adjustable set point in middle of range and adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- I. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
- J. Electric High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.

2.7 AIRFLOW/TEMPERATURE MEASUREMENT DEVICES

- A. Provide airflow/temperature measurement devices where indicated on the drawings.
- B. Each measurement device shall consist of one or more sensor probe assemblies and a single microprocessor-based transmitter. Each sensor probe assembly will contain one or more independently wired sensor housings. Multiple sensor housings shall be equally weighted and averaged by the transmitter prior to output.
- C. All Sensor Probe Assemblies
 - 1. Each sensor housing shall be manufactured of a U.L. listed engineered thermoplastic
 - 2. Each sensor housing shall utilize two hermetically sealed, bead-in-glass thermistor probes to determine airflow rate and ambient temperature.
 - 3. Each sensor housing shall be calibrated at a minimum of 16 airflow rates and have an accuracy of +/-2% of reading over the entire operating airflow range. Each sensor assembly shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).

4. Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.
5. The operating temperature range for the sensor probe assembly shall be -20° F to 160° F. The operating humidity range for the sensor probe assembly shall be 0-99% RH (non-condensing).
6. Each temperature sensor shall be calibrated at a minimum of 3 temperatures and have an accuracy of +/-0.15° F over the entire operating temperature range. Each temperature sensor shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).
7. Each sensor probe assembly shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to a remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated.
8. Each sensor assembly shall not require matching to the transmitter in the field.
9. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter at a given measurement location.

D. Duct and Plenum Sensor Probe Assemblies

1. Sensor housings shall be mounted in an extruded, gold anodized, 6063 aluminum tube probe assembly. Probe assembly mounting brackets shall be constructed of 304 stainless steel.
2. The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

E. Fan Inlet Sensor Probe Assemblies

1. Sensor housings shall be mounted on 304 stainless steel blocks
2. Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.
3. Mounting feet shall be constructed of 304 stainless steel
4. The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the drawings.

2.8 FLOW-MEASURING SYSTEMS

A. System includes calibrated flow element, separate meter, hoses or tubing, valves, fittings, and conversion chart compatible with flow element, meter, and system fluid.

1. Flow range of flow-measuring element and meter covers operating range of equipment or system where used.
2. Display: Visual instantaneous rate of flow.
3. Display: Visual instantaneous rate of flow, with register to indicate total volume in **gallons** (liters).

B. Permanent Meters: Suitable for wall or bracket mounting. Include **6-inch**- diameter, or equivalent, dial with fittings and copper tubing for connecting to flow element.

1. Scale: **Gallons per minute**.
2. Accuracy: Plus or minus 1 percent of center 60 percent of range.

C. Portable Meters: Differential-pressure gage. Include two **12-foot** hoses in carrying case with handle.

1. Scale: **Inches** of water, unless otherwise indicated.
 2. Accuracy: Plus or minus 2 percent between 20 and 80 percent of range.
- D. Include complete operating instructions with each meter.
- E. Wafer-Orifice Flow Elements: Differential-pressure-design, orifice-insert flow element made for installation between pipe flanges.
1. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
 2. Pressure Rating: **300 psig**.
 3. Temperature Rating: **250 deg F**.

2.9 TURBINE FLOWMETERS

- A. Description: Insertion type dual turbine; measures flow directly in **gallons per minute**.
1. Construction: Bronze or stainless-steel body and plastic turbine or impeller, with integral direct-reading scale.
 2. Dual Turbine Flow Meter complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown.
 - a. The flow meter shall be hand-insertable up to 400 psi.
 - b. The flow meter shall have two contra-rotating axial turbines, with electronic impedance-based sensing and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion.
 - c. Wetted metal components shall be nickel-plated brass (unless optional 316L SS is otherwise specified). Optional 316L SS construction is required for HW applications operating over 250 degrees F and for any application in non-metallic pipe. The maximum operating temperature shall be 280 degrees F, 300 F peak.
 - d. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*. The manufacturer's certificate of calibration shall be provided with each flow meter.
 - e. Accuracy shall be within $\pm 0.5\%$ of rate at the calibrated velocity, within $\pm 1\%$ of rate over a 10:1 turndown (3.0 to 30 ft/s) and within $\pm 2\%$ of rate over a 50:1 turndown (from 0.4 to 20 ft/s).
 - f. The flow meter shall include integral analog output(s), 4-20 mA, 0-10V, or 0-5V. Bi-directional meters shall include an isolated contact closure output for direction.
 - g. The flow meter shall be covered by the manufacturer's two year warranty.

2.10 ACTUATORS

- A. Electric Operators: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
- B. Pneumatic Valve Operators: Rolling-diaphragm, spring-loaded, piston type with spring range as required and start-point adjustment. Operator shall maintain full shutoff at maximum pump differential pressure.

- C. Pneumatic Damper Operators: Rolling-diaphragm, piston type with adjustable stops and spring return, sized to operate with sufficient reserve power to provide smooth modulating action or two-position action. Where actuators operate in sequence, provide pilot positioners.
 - 1. Pilot Positioners: Start point adjustable from 2 to 12 psig, and operating span adjustable from 5 to 13 psig.
 - 2. Inlet-Vane Operators: High pressure with pilot positioners.

2.11 CONTROL VALVES

- A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- B. Globe Valves NPS 2 and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
- C. Globe Valves NPS 2-1/2 and Larger: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
- D. Hydronic system globe valves shall have the following characteristics:
 - 1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
 - 2. Internal Construction: Replaceable plugs and seats of stainless steel or brass.
 - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
 - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
 - 3. Sizing: 3-psig maximum pressure drop at design flow rate.
 - 4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.
- E. Steam system globe valves shall have the following characteristics:
 - 1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
 - 2. Internal Construction: Replaceable plugs and seats of stainless steel.
 - 3. Sizing: Pressure drop across steam valve at a maximum flow of 80 percent of inlet pressure for low-pressure systems and 42 percent for high-pressure systems.
 - 4. Flow Characteristics: Modified linear characteristics.
- F. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
 - 1. Body Style: Lug.
 - 2. Disc Type: Nickel-plated ductile iron.

3. Sizing: 1-psig maximum pressure drop at design flow rate.
- G. Terminal Unit Control Valves: Bronze body, bronze trim, two- or three-port as indicated, replaceable plugs and seats, union and threaded ends.
1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
 2. Sizing: 3 to 5 psig maximum pressure drop at design flow rate, to close against pump shutoff head.
 3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

2.12 DAMPERS

- A. Dampers: AMCA-rated, opposed-blade design; 0.1084-inch minimum, galvanized-steel frames with holes for duct mounting; damper blades shall not be less than 0.0635-inch galvanized steel with maximum blade width of 8 inches.
1. Blades shall be secured to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
 2. Operating Temperature Range: From minus 40 to plus 200 deg F.
 3. For standard applications, include closed-cell neoprene edging.
 4. For low-leakage applications, use parallel- or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4 inches wg when damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that power supply is available to control units and operator workstation.
- B. Verify that duct, pipe, and equipment-mounted devices and wiring and pneumatic piping are installed before proceeding with installation.

3.2 INSTALLATION

- A. Install software in control units and operator workstation. Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate all 48 inches above the floor.

- D. Install room thermostats(or temperature sensors) with setpoint adjustments in private offices. Room thermostats in public locations shall not have setpoint adjustment feature.
- E. Install labels and nameplates to identify control components.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceways and Boxes."
- B. Install building wire and cable according to Division 26 Section "Conductors and Cables."
- C. Install signal and communication cable according to Division 26 Section "Control/Signal Transmission Media."
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Install concealed cable in raceway.
 - 4. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
- B. Engage a factory-authorized service representative to perform startup service.
- C. Replace damaged or malfunctioning controls and equipment.
 - 1. Start, test, and adjust control systems.
 - 2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
 - 3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.
- D. Verify DDC as follows:
 - 1. Verify software including automatic restart, control sequences, scheduling, reset controls, and occupied/unoccupied cycles.
 - 2. Verify operation of operator workstation.
 - 3. Verify local control units including self-diagnostics.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 - 2. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of 40 hours' dedicated instructor time on-site.
 - 3. Review data in maintenance manuals.
 - 4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

3.6 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

END OF SECTION 230900

SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes fuel gas piping, specialties, and accessories within the building.

1.2 PROJECT CONDITIONS

- A. Design values of fuel gas supplied for these systems are as follows:
 - 1. Nominal Heating Value: 1000 Btu/cu. ft.
 - 2. Nominal Specific Gravity: 0.6.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 2. Pressure regulators. Include pressure rating, capacity, and settings of selected models.
- B. Shop Drawings: For fuel gas piping. Include plans and attachments to other Work.

1.4 QUALITY ASSURANCE

- A. ANSI Standard: Comply with ANSI Z223.1, "National Fuel Gas Code."
- B. UL Standard: Provide components listed in UL's "Gas and Oil Equipment Directory" if specified to be UL listed.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 PIPES, TUBES, FITTINGS, AND JOINING MATERIALS

- A. Steel Pipe: ASTM A 53; Type E or S; Grade B; Schedule 40; black.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
3. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
4. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
5. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
6. Joint Compound and Tape: Suitable for natural gas.
7. Steel Flanges and Flanged Fittings: ASME B16.5.
8. Gasket Material: Thickness, material, and type suitable for natural gas.

- B. Transition Fittings: Type, material, and end connections to match piping being joined.
- C. Common Joining Materials: Refer to Division 22 Section "Basic Mechanical Materials and Methods" for joining materials not in this Section.

2.3 PROTECTIVE COATING

- A. Furnish underground pipe and fittings with factory-applied, corrosion-resistant polyethylene coating for use underground.

2.4 SPECIALTY VALVES

- A. Gas Valves, NPS 2 and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating.
- B. Plug Valves, NPS 2-1/2 and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.
- B. Fuel Gas Piping up to 5 psig: Use the following:
1. NPS 2 and Smaller: Steel pipe, malleable-iron threaded fittings, and threaded joints.
 2. NPS 2-1/2 to NPS 4: Steel pipe, steel welding fittings, and welded joints.
 3. Larger Than NPS 4: Steel pipe, steel welding fittings, and welded joints.

3.2 PIPING INSTALLATION

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping installation requirements.
- B. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
- C. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- D. Connect branch piping from top or side of horizontal piping.
- E. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
- F. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.
- G. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.
- H. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.
- I. Install containment conduits for gas piping below slabs, within building, in gastight conduits extending minimum of 4 inches outside building, and vented to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal-tar, epoxy-polyamide paint according to SSPC-Paint 16.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 23 Section "Hangers and Supports" for pipe hanger and support devices.
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 - 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.4 CONNECTIONS

- A. Install piping adjacent to appliances to allow service and maintenance.
- B. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.
- C. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.5 PAINTING

- A. Paint exterior piping two coats of exterior grade paint designed to prevent rust and corrosion. Color as selected by the architect.

3.6 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator, and specialty valve.
 - 1. Refer to Division 23 Section for nameplates and signs.

3.7 FIELD QUALITY CONTROL

- A. Inspect, test, and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing, and Purging," and requirements of authorities having jurisdiction.

3.8 ADJUSTING

- A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

END OF SECTION 231123

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Hot-water heating piping.
 - 2. Chilled-water piping.
 - 3. Makeup-water piping.
 - 4. Condensate-drain piping.
 - 5. Pre-insulated piping for underground use.
- B. See Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.2 SUBMITTALS

- A. Product Data: For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.
- B. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications." Certified welding shall be performed where required by code.
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.4 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe, ASTM A 53, ASTM A 106, Schedule 40, black steel.
- B. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- C. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

2.4 PLASTIC PIPE AND FITTINGS

- A. PVC Plastic Pipe Fittings:
 - 1. PVC compound meets ASTM D 1784, cell class 12454
 - 2. Pipe meets AWWA C900
 - 3. Pipe system is pressure class 150 meeting requirements of DR 18
 - 4. Elastomer seal: Integral bell pipe provided with factory installed gaskets meeting requirements of ASTM F 447
 - 5. Gasket joint assembly meets requirements of ASTM D 3139
 - 6. Installation meets AWWA C605 requirements

2.5 PRE-INSULATED PIPE AND FITTINGS

- A. Preinsulated Piping - Furnish a complete PVC jacketed system of factory preinsulated steel piping for the hot water distribution service. All preinsulated pipe, fittings, insulating materials, and technical support shall be provided by the Preinsulated Piping System manufacturer.
- B. A complete layout of the system, showing anchors, expansion provisions, and building entrance details, shall be provided by the preinsulated pipe manufacturer. Means for expansion must be made in pipe off-sets or loops.
- C. Carrier pipe shall be steel ASTM A-53, Schedule 40, black steel. All carbon steel pipe shall have ends cut square and beveled for butt-welding. Straight sections of factory insulated pipe shall have 6" of exposed pipe at each end for field joint fabrication.
- D. Insulation shall be polyurethane foam either spray applied or high pressure injected with one shot into the annular space between carrier pipe and jacket. Insulation shall be rigid, 90-95% closed cell polyurethane with a 2.0 to 3.0 pounds per cubic foot density and coefficient of thermal conductivity (K- Factor) of 0.14 and shall conform to ASTM C-591. Maximum operating temperature shall not exceed 250°F. Insulation thickness shall be specified by calling out appropriate carrier pipe and jacket size combinations as listed on FTSG 7.108.

- E. Jacketing material shall be Jacketing material shall be seamless PVC jacket of not less than .070 inches thick. To protect and preserve the insulation, each length of insulated pipe will be provided with a waterproof seal at each end. This shall create a jacket that is seamless throughout the entire system with the exception of anchors, prohibiting the ingress of water.
- F. Moisture barrier end seals shall be factory applied, sealed to the jacket and carrier pipe. End seals shall be certified as having passed a 20-foot head pressure test. End seals shall be high temperature mastic completely sealing the exposed end of the insulation. Field applied end seals shall be installed at any field cut to the piping before continuing with the installation.
- G. Straight run joints are insulated using polyurethane foam to the thickness specified, jacketed with either an electro-fusion welded split sleeve HDPE joint closure, Canusa Supercase, or Raychem Rayjoint. The joint will be pressure tested at 5 psi for 5 minutes while simultaneously soap tested at the joint closure's seams for possible leaks. After passing the pressure test, the field joint is insulated and a closure patch is welded (as per joint closure instructions) over the foam holes. All joint closures and insulation shall occur at straight sections of pipe.
- H. Fittings are factory prefabricated and preinsulated with polyurethane foam to the thickness specified and jacketed with a one piece seamless molded HDPE fitting cover, a butt fusion welded, or an extrusion welded and mitered HDPE jacket. All fitting jackets/covers shall be connected to the straight lengths of pipe by electro fusion, butt fusion, or extrusion welding. Carrier pipe fittings shall be butt-welded, except sizes smaller than 2" shall be socket-welded. Fittings include expansion loops, elbows, tees, reducers and anchors. Elbows, loops, offsets, or any other direction changes shall conform to the standards set by ANSI B31.1, Code for Power Piping.
- I. Expansion/contraction compensation will be accomplished utilizing factory prefabricated and preinsulated expansion elbows, Z-bends, expansion loops and anchors specifically designed for the intended application. External expansion compensation utilizing flexible expansion pads (minimum one inch thickness), extending on either side, both inside and outside the radius of the fittings used, with all fittings having expansion in excess of 1/2".
- J. Terminal ends of conduits inside manholes, pits or building walls shall be equipped with end seals consisting of a 1/2" steel plate welded to the pipe and conduit. End seals shall be equipped with drain and vent openings. Terminate all conduits 2" beyond the inside face of manhole or building walls.
- K. Prefabricated anchors shall be furnished and installed where shown on plans and shall consist of a steel plate, welded to pipe and conduit. The steel anchor plate shall be 1/2" thick and shall be 5" larger horizontally and 2" larger vertically than the HDPE jacket outer diameter. Heat shrink wrap shall be used seal the overlap of anchor water shed over the HDPE jacket.
- L. A concrete thrust block shall be cast over the anchor plate and conduit, large enough for firm anchorage into undisturbed trench sidewalls and/or bottom. The concrete block shall be at least 36" in length and extend a minimum of 12" beyond the top and bottom of the anchor plate.

- M. Wall sleeves with leak plates shall be provided at all building and manhole entries to provide an effective moisture barrier. The space between the conduit and wall sleeve shall be made watertight by use of Link-Seal or equal assemblies, which will also provide electrical isolation.
- N. Insulation shall be polyurethane foam insulation minimum thickness of 1". Insulation shall be rigid, 90-95% closed cell polyurethane with 2.0 to 2.5 pounds per cubic foot density and coefficient of thermal conductivity (K factor) of .14 per ASTM C518. The urethane shall conform to ASTM C591.
- O. When steel carrier pipe is used underground, a heavy coat of asphalt mastic is to be applied to the exposed portions of the carrier pipe and fittings, before field insulation kits are installed, to provide for additional protection against corrosion.

2.6 VALVES

- A. Gate, globe, check, ball, butterfly, and balancing valves are specified in Division 23 Section "Valves." Provide valve box for underground valves.
- B. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.
- C. Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV.

2.7 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.
- B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection.
- C. Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested with taps fabricated and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. Include the following fittings and accessories:
 - 1. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, sized for compression-tank diameter. Design tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.

2. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; designed to admit air to compression tank, drain water, and close off system.
 3. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- diameter gage glass, and slotted-metal glass guard.
- D. Tangential-Type Air Separators: Welded black steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature. Perforated stainless-steel air collector tube designed to direct released air into expansion tank; tangential inlet and outlet connections; threaded connections for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger; threaded blowdown connection. Provide units in sizes for full-system flow capacity.
- E. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure with fill funnel and inlet, outlet, and drain valves.
- F. Y-Pattern Strainers: 125-psig working pressure; bronze or cast-iron body, flanged ends for NPS 2-1/2 and larger, threaded connections for NPS 2 and smaller, bolted cover, perforated type 304 stainless-steel basket, and bottom blowdown connection. 20 mesh perforations for sizes up through 2" and 1/16" perforations for larger sizes.
- G. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged- or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.
- 2.8 DIELECTRIC FITTINGS
- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion. Use dielectric unions for all piping systems whether connecting similar or dissimilar pipe materials.
- B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Chilled Water, NPS 2 and smaller: Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints.
- B. Chilled Water, NPS 2-1/2 and larger: Above ground use schedule 40 steel pipe with welded and flanged joints. Copper piping may be used in lieu of schedule 40 black steel at the contractors discretion.
- C. Chilled Water, NPS 2-1/2 and larger. Below grade use pre-insulated pipe.

- D. Hot Water, NPS 2 and smaller: Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints. Use copper piping for pipe risers and horizontal runs in the Dorm Rooms and within the valance enclosures.
- E. Hot Water, NPS 2-1/2 and larger: Above ground use schedule 40 steel pipe with welded and flanged joints. Copper piping may be used in lieu of schedule 40 black steel at the contractors discretion.
- F. Condensate Drain Lines: Type L drawn-temper copper tubing with soldered joints.

3.2 PIPING INSTALLATIONS

- A. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- B. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- C. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- D. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- E. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- F. Anchor piping for proper direction of expansion and contraction.
- G. Install underground piping with bedding and anchor/thrust block restraints in compliance with the manufacturer's instructions.

3.3 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports." Comply with requirements of the International Building Code and recommendations of MSS whichever is more stringent.

3.4 PRE-INSULATED PIPE INSTALLATION

- A. Pre-engineered systems shall be provided with all straight pipe and fittings factory preinsulated and prefabricated to job dimensions.
- B. Underground systems shall be buried in a trench not less than two (2) feet deeper than the top of the pipe and not less than eighteen inches wider than the combined O.D. of all piping systems. A minimum thickness of 24 inches of compacted backfill placed over the top of the pipe will meet H-20 highway loading.

- C. Trench bottom shall have a minimum of 6" of sand, pea gravel, or backfill material as a cushion for the piping. All field cutting of the pipe shall be performed in accordance with the manufacturer's installation instructions.
- D. A hydrostatic pressure test of the carrier pipe shall be performed at one and one-half times the normal system operating pressure or a minimum of 125 psi for not less than two hours. Care shall be taken to insure all trapped air is removed from the system prior to the test.
- E. Field Service shall be provided by a certified manufacturer's representative or company field service technician. The technician will be available at the job a minimum of one day (or more if required by job size) to check unloading, storing, and handling of pipe, pipe installation, pressure testing, field joint insulation and backfilling techniques.

3.5 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install manual drains at low points in piping, at heat-transfer coils, and elsewhere as required for system draining.
- C. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
- D. Install expansion tanks above air separator. Install gage glass and cocks on end of tank. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 - 1. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, and fittings, plus weight of a full tank of water. Do not overload building components and structural members.

3.6 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Flush system with clean water. Clean strainers.
- B. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

System	Pressure	Medium	Duration
Chilled water	150 psig	water	4 hours

Hot water	150 psig	water	4 hours
Cold water (domestic)	150 psig	water	4 hours

2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure, but not less than the pressures indicated above. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
3. Prepare written report of testing.

3.7 CLEANING

- A. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

END OF SECTION 232113

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following categories of pumps for hydronic systems:

1. In-line circulators.
2. End-suction pumps.
3. Automatic condensate pump units.

B. Related Sections include the following:

1. Division 23 Section "Motors" for general motor requirements.

1.2 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities; shipping, installed, and operating weights; furnished specialties; final impeller dimensions; and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Maintenance Data: For pumps to include in maintenance manuals.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store pumps in dry location.

B. Retain protective covers for flanges and protective coatings during storage.

C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

D. Comply with pump manufacturer's written rigging instructions.

1.4 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. End Suction, and In-Line Circulators:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett ITT; Div. of ITT Fluid Technology Corp.
 - c. Weinman
2. Automatic Condensate Pump Units:
 - a. Beckett Corp.
 - b. Hartell Div.; Milton Roy Co.
 - c. Little Giant Pump Co.

2.2 GENERAL PUMP REQUIREMENTS

- A. Pump Units: Factory assembled and tested.
- B. Motors: Include grease-lubricated ball bearings. Select each motor to be nonoverloading over full range of pump performance curve.

2.3 IN-LINE CIRCULATORS

- A. Description: Horizontal, in-line, centrifugal, single-stage, bronze-fitted, radially split case design; rated for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.
1. Casing: Cast iron, with threaded companion flanges for piping connections, and threaded gage tappings at inlet and outlet connections.
 2. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, closed, overhung, single suction, and keyed to shaft. or ASTM B 36/B 36M, rolled-temper-brass fabrication, statically and dynamically balanced, closed, overhung, single suction, and keyed to shaft.
 3. Shaft and Sleeve: Stainless Steel shaft with oil-lubricated copper sleeve.
 4. Seals: Mechanical type. Include carbon-steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and gasket.
 5. Pump Bearings: Oil-lubricated, bronze journal and thrust type.
 6. Motor Bearings: Oil-lubricated, sleeve type.
 7. Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
 8. Motor: Resiliently mounted to pump casing.

2.4 FLEXIBLE-COUPLED, END-SUCTION PUMPS

- A. Description: Base-mounted, centrifugal, flexible-coupled, end-suction, single-stage, bronze-fitted, back-pull-out, radially split case design; rated for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
1. Casing: Cast iron, with flanged piping connections, drain plug at low point of volute, threaded gage tappings at inlet and outlet connections, and integral feet

or other means on volute to support weight of casing and attached piping. Casing shall allow removal and replacement of impeller without disconnecting piping.

2. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, closed, overhung, single suction, keyed to shaft, and secured by locking cap screw.
3. Shaft: Ground and polished stainless-steel shaft with axially split spacer coupling.
4. Seals: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and gasket.
5. Coupling: Flexible-spacer type, capable of absorbing torsional vibration and shaft misalignment; with flange and sleeve section that can be disassembled and removed without removing pump or motor.
6. Coupling Guard: Steel, removable, and attached to mounting frame.
7. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate for mounting pump casing, coupling guard, and motor.
8. Motor: Secured to mounting frame, with adjustable alignment.

2.5 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle or straight pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory- or field-fabricated support.
- B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features.

2.6 AUTOMATIC CONDENSATE PUMP UNITS

- A. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch-minimum, electrical power cord with plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation.
 1. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
 2. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Install pumps according to manufacturer's written instructions.
- B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so piping is not supported by pumps.
- D. Suspend in-line pumps using continuous-thread hanger rod and vibration-isolation hangers. Install seismic bracing as required by authorities having jurisdiction.
- E. Set base-mounted pumps on concrete foundation. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.
 - 1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
 - 2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.
- F. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

3.3 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting them on foundations, after grout has been set and foundation bolts have been tightened, and after piping connections have been made.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

- A. Install piping adjacent to machine to allow service and maintenance.
- B. Install check valve and throttling valve or triple duty valve on discharge side of pumps.
- C. Install strainer, suction diffuser and shutoff valve on suction side of pumps.

- D. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- E. Install pressure gages on pump suction and discharge. Install at integral pressure-gage tapings where provided.
- F. Install electrical connections for power, controls, and devices.

3.5 COMMISSIONING

- A. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.
- B. Perform the following preventive maintenance operations and checks before starting:
 - 1. Lubricate bearings.
 - 2. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
 - 3. Verify that pumps are free to rotate by hand and that pumps for handling hot liquids are free to rotate with pumps hot and cold. Do not operate pumps if they are bound or drag, until cause of trouble is determined and corrected.
 - 4. Clean strainers.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
 - 2. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
 - 3. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
 - 4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 232123

SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following HVAC water-treatment systems:

1. Bypass chemical-feed equipment and controls.
2. Chemical treatment test equipment.
3. HVAC water-treatment chemicals.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes water-treatment systems for the following:

1. Heating, hot-water piping (closed-loop system).
2. Chilled-water piping (closed-loop system).

1.4 CHEMICAL FEED SYSTEM DESCRIPTION

A. Closed-Loop System: One bypass feeder on each system with isolating and drain valves downstream from circulating pumps, unless otherwise indicated.

1. Introduce chemical treatment through bypass feeder when required or indicated by test.

1.5 PERFORMANCE REQUIREMENTS

A. Maintain water quality for HVAC systems that controls corrosion and build-up of scale and biological growth for maximum efficiency of installed equipment without posing a hazard to operating personnel or the environment.

B. Base chemical treatment performance requirements on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

1. Closed System: Maintain system essentially free of scale, corrosion, and fouling:

1.6 SUBMITTALS

- A. Product Data: Include rated capacities; water-pressure drops; shipping, installed, and operating weights; and furnished products listed below:
 - 1. Chemical solution tanks.
 - 2. Agitators.
 - 3. Control equipment and devices.
 - 4. Test equipment.
 - 5. Chemicals.
 - 6. Filters.
 - 7. Chemical feeders.
- B. Shop Drawings: Detail equipment assemblies indicating dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Detail power and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.
- D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- E. Maintenance Data: For pumps, agitators, filters, system controls, and accessories to include in maintenance manuals specified in Division 1.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is an authorized representative of the chemical treatment manufacturer for both installation and maintenance of chemical treatment equipment required for this Project.

1.8 MAINTENANCE

- A. Scope of Service: Provide chemicals and service program for maintaining optimum conditions in the circulating water for inhibiting corrosion, scale, and organic growths in the cooling, chilled-water piping, heating, hot-water piping, heating, steam and condensate piping, and condenser water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, including the following:
 - 1. Initial water analysis and recommendations.
 - 2. Startup assistance.
 - 3. Periodic field service and consultation.
 - 4. Customer report charts and log sheets.
 - 5. Laboratory technical assistance.
 - 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 CHEMICAL FEEDING EQUIPMENT

- A. Bypass Feeders: Cast iron or steel, for introducing chemicals into system; with funnel shutoff valve on top, air-release valve on top, drain valve on bottom, and recirculating shutoff valves on sides.
 - 1. Capacity: 5 gal.
 - 2. Working Pressure: 125 psig.
- B. Drip Feeders: Plastic reservoir with capillary tubing probe, weight, charging syringe, and clip.

2.2 CHEMICALS

- A. Furnish chemicals recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment.
- B. System Cleaner: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.
- C. Closed-Loop, Water Piping Chemicals: Sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to maintain the water quality as specified in "Performance Requirements" Article.

3.2 INSTALLATION

- A. Install treatment equipment level and plumb.
- B. Add cleaning chemicals as recommended by manufacturer.

3.3 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to perform startup service.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 232500

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

This Section includes rectangular, round, and flat-oval metal ducts and plenums for heating, ventilating, and air-conditioning systems in pressure classes from minus 2 to plus 10-inch wg

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.3 SUBMITTALS

- A. Product Data: For duct sealing materials.
- B. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

1.4 QUALITY ASSURANCE

- A. Welding Standards: Qualify welding procedures and welding personnel to perform welding processes for this Project according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports; AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members; and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," unless otherwise indicated.
- C. Comply with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems," unless otherwise indicated.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.
- B. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, exposed matte finish.
- C. Stainless Steel: ASTM A 480/A 480M, Type 316, sheet form with No. 4 finish for surfaces of ducts exposed to view and for all fume hood exhaust; and Type 304, sheet form with No. 1 finish for concealed ducts.
- D. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 DUCT LINER

- A. General: Duct liner shall not be used.

2.3 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
 - 1. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with tape to form a hard, durable, airtight seal.
 - 2. Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant, formulated with a minimum of 75 percent solids.
 - 3. Flanged Joint Mastics: One-part, acid-curing, silicone, elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

2.4 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for building materials.
- B. Hanger Materials: Galvanized, sheet steel or round, threaded steel rod.
 - 1. Hangers: Electrogalvanized or cadmium coated all-thread rod or galvanized rods with threads painted after installation.
 - 2. Straps and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for sheet steel width and thickness and for steel rod diameters.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
 - 1. Supports for Galvanized-Steel Ducts: Galvanized steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
 - 3. Supports for Aluminum Ducts: Aluminum support materials, unless materials are electrolytically separated from ductwork.

2.5 RECTANGULAR DUCT FABRICATION

- A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction with galvanized, sheet steel, according to SMACNA's "HVAC Duct Construction Standards-Metal and Flexible." Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals. Joining methods shall comply with SMACNA standards. All exhaust ductwork shall have welded seams and joints.
- B. Fabricate range hood exhaust ducts with carbon-steel sheet for concealed ducts and stainless steel for exposed ducts. Weld and flange seams and joints. Metal thickness and construction shall comply with NFPA 96.
- C. Fabricate dishwasher hood exhaust ducts with 0.0500-inch- thick stainless steel. Weld and flange seams and joints.
- D. Fabricate fume hood exhaust duct from type 316 stainless steel with longitudinal welded seam
- E. Static-Pressure Classifications: Unless otherwise indicated, construct ducts to the following:
 - 1. Supply Ducts upstream of air terminals: 6-inch water gauge.
 - 2. Supply ducts downstream of air terminals: 2-inch water gauge
 - 3. Exhaust ducts upstream of air terminals: 2-inch water gauge.
 - 4. Exhaust ducts downstream of air terminals: 4-inch water gauge
 - 5. Return Ducts: 2-inch wg, negative pressure.

2.6 ROUND AND FLAT-OVAL DUCT FABRICATION

- A. General: Diameter as applied to flat-oval ducts in this Article is the diameter of the size of round duct that has a circumference equal to perimeter of a given size of flat-oval duct.
- B. Round Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- C. Flat-Oval Ducts: Fabricate supply ducts with standard spiral lock seams or with butt-welded longitudinal seams according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

- D. Double-Wall (Insulated) Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner perforated liner with an insulation retaining fabric to prevent corrosion. Dimensions indicated on internally insulated ducts are inside dimensions.
 - 1. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
 - 2. Outer Shell: Base outer-shell metal thickness on actual outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner shell and insulation, and in metal thickness specified for single-wall duct.
 - 3. Insulation: 1 1/2-inch- thick fibrous-glass insulation, unless otherwise indicated. Terminate insulation where internally insulated duct connects to single-wall duct or uninsulated components. Terminate insulation and reduce outer duct diameter to inner liner diameter.
 - 4. Perforated Inner Liner: Fabricate round and flat-oval inner liners with perforated sheet metal with a fabric insulation retainer.
 - 5. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.

2.7 ROUND AND FLAT-OVAL SUPPLY AND EXHAUST FITTING FABRICATION

- A. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal seam straight duct.
- B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.
- C. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate bend radius of die-formed, gored, and pleated elbows one and one-half times elbow diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
- D. Double-Wall (Insulated) Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner liner. Dimensions indicated on internally insulated ducts are inside dimensions.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION, GENERAL

- A. Supply ductwork shall be constructed of G90 galvanized sheet metal.
- B. Return ductwork shall be constructed of G90 galvanized sheet metal.
- C. Toilet exhaust and general exhaust ductwork shall be constructed of G90 galvanized sheet metal.
- D. Round or flat oval ductwork exposed in finished areas of the building shall be insulated double wall duct construction.

- E. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts, fittings, and accessories.
- F. Construct and install each duct system for the specific duct pressure classification indicated.
- G. Install ducts with fewest possible joints.
- H. Install fabricated fittings for changes in directions, changes in size and shape, and connections.
- I. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs.
- J. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.
- K. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- L. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.
- N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire damper, sleeve, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Firestopping."

3.2 SEAM AND JOINT SEALING

- A. General: Seal duct seams and joints according to the duct pressure class indicated and as described in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Seal externally insulated ducts before insulation installation.

3.3 HANGING AND SUPPORTING

- A. Install rigid round, rectangular, and flat-oval metal duct with support systems indicated in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

- C. Support vertical ducts at a maximum interval of 16 feet and at each floor.
- D. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- E. Install concrete inserts before placing concrete.
- F. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3.4 CONNECTIONS

- A. Connect equipment with flexible connectors according to Division 23 Section "Duct Accessories."
- B. For branch, outlet and inlet, and terminal unit connections, comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

3.5 RANGE HOOD EXHAUST DUCT INSTALLATIONS

- A. Install ducts to allow for thermal expansion of ductwork through 2000 deg F temperature range.
- B. Install ducts without dips or traps that may collect residues.
- C. Install access openings at each change in direction and at 50-foot intervals; locate on sides of duct a minimum of 1-1/2 inches from bottom; and fit with grease-tight covers of same material as duct.
- D. Do not penetrate fire-rated assemblies.

3.6 DISHWASHER EXHAUST DUCT INSTALLATIONS

- A. Install dishwasher exhaust ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

3.7 FUME HOOD EXHAUST DUCT INSTALLATIONS

- A. Install fume exhaust ducts to comply with NFPA. Duct construction shall be 18 gauge minimum.

3.8 FIELD QUALITY CONTROL

- A. Disassemble, reassemble, and seal segments of systems as required to accommodate leakage testing and as required for compliance with test requirements.

- B. Medium pressure ductwork shall be tested per SMACNA standards. Low pressure ductwork shall be "spot tested" for compliance with leakage criteria.
- C. Conduct tests, in presence of Architect, at static pressures equal to maximum design pressure of system or section being tested. If pressure classifications are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
- D. Determine leakage from entire system or section of system by relating leakage to surface area of test section.
- E. Maximum Allowable Leakage: Comply with requirements for Leakage Classification 3 for round and flat-oval ducts, Leakage Classification 12 for rectangular ducts in pressure classifications less than and equal to 2-inch wg (both positive and negative pressures), and Leakage Classification 6 for pressure classifications from 2- to 10-inch wg.
- F. Remake leaking joints and retest until leakage is less than maximum allowable.
- G. Leakage Test: Perform tests according to SMACNA's "HVAC Air Duct Leakage Test Manual."

3.9 ADJUSTING

- A. Adjust volume-control dampers in ducts, outlets, and inlets to achieve design airflow.

3.10 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect the system. Vacuum ducts before final acceptance to remove dust and debris.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Backdraft dampers.
 - 2. Manual-volume dampers.
 - 3. Fire and smoke dampers.
 - 4. Turning vanes.
 - 5. Duct-mounted access doors and panels.
 - 6. Flexible ducts.
 - 7. Flexible connectors.
 - 8. Duct accessory hardware.

1.2 SUBMITTALS

- A. Product Data: For the following:
 - 1. Backdraft dampers.
 - 2. Manual-volume dampers.
 - 3. Fire and smoke dampers.
 - 4. Duct-mounted access doors and panels.
 - 5. Flexible ducts.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, location, and size of each field connection. Detail the following:
 - 1. Special fittings and manual- and automatic-volume-damper installations.
 - 2. Fire- and smoke-damper installations, including sleeves and duct-mounted access doors and panels.
- C. Product Certificates: Submit certified test data on dynamic insertion loss; self-noise power levels; and airflow performance data, static-pressure loss, dimensions, and weights.

1.3 QUALITY ASSURANCE

- A. NFPA Compliance: Comply with the following NFPA standards:
 - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.4 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 (Z275) coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.
- B. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.
- C. Aluminum Sheets: ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14, sheet form; with standard, one-side bright finish for ducts exposed to view and mill finish for concealed ducts.
- D. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches

2.2 BACKDRAFT DAMPERS

- A. Description: Suitable for horizontal or vertical installations.
- B. Frame: 0.052-inch- thick, galvanized, sheet steel, with welded corners and mounting flange.
- C. Frame: 0.052-inch- thick, galvanized, sheet steel, with welded corners.
- D. Frame: 0.063-inch- thick extruded aluminum, with mounting flange.
- E. Frame: 0.063-inch- thick extruded aluminum.
- F. Blades: 0.025-inch- thick, roll-formed aluminum.
- G. Blades: 0.050-inch- thick aluminum sheet.
- H. Blade Seals: Felt.
- I. Blade Seals: Vinyl.
- J. Blade Seals: Neoprene.
- K. Blade Axles: Nonferrous.
- L. Blade Axles: Galvanized steel.
- M. Tie Bars and Brackets: Aluminum.
- N. Tie Bars and Brackets: Galvanized steel.
- O. Return Spring: Adjustable tension.

2.3 MANUAL-VOLUME DAMPERS

- A. General: Factory fabricated with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classifications of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
- B. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
- C. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, and suitable for horizontal or vertical applications.
 1. Steel Frames: Hat-shaped, galvanized, sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 2. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 3. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized, sheet steel.
 4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 5. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 6. Blade Axles: Nonferrous.
 7. Blade Axles: Galvanized steel.
 8. Tie Bars and Brackets: Aluminum.
 9. Tie Bars and Brackets: Galvanized steel.
- D. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, and suitable for horizontal or vertical applications.
 1. Steel Frames: Hat-shaped, galvanized, sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 2. Aluminum Frames: Hat-shaped, 0.063-inch- thick, extruded-aluminum channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 3. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized, sheet steel.
 4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 5. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 6. Blade Seals: Felt.
 7. Blade Seals: Vinyl.
 8. Blade Seals: Neoprene.
 9. Blade Axles: Nonferrous.
 10. Blade Axles: Galvanized steel.

11. Tie Bars and Brackets: Aluminum.
 12. Tie Bars and Brackets: Galvanized steel.
 - E. High-Performance Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
 1. Steel Frames: Hat-shaped, galvanized steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 2. Aluminum Frames: Hat-shaped, 0.125-inch- thick, extruded-aluminum channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 3. Steel Blades: 0.052-inch-thick, galvanized, sheet steel; airfoil shaped.
 4. Extruded-Aluminum Blades: Minimum of 0.081-inch- thick, 6063T extruded aluminum.
 5. Blade Seals: Dual-durometer vinyl on blade edges; metallic compression on jambs.
 6. Blade Axles: Nonferrous.
 7. Blade Axles: Galvanized steel.
 8. Tie Bars and Brackets: Aluminum.
 9. Tie Bars and Brackets: Galvanized steel.
 - F. Jackshaft: 1-inch-diameter, galvanized steel pipe rotating within a pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 1. Length and Number of Mountings: Appropriate to connect linkage of each damper of a multiple-damper assembly.
 - G. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.
- 2.4 FIRE DAMPERS
- A. General: Labeled to UL 555.
 - B. Fire Rating: One and one-half and three hours.
 - C. Frame: SMACNA Type A with blades in airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
 - D. Frame: SMACNA Type B with blades out of airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
 - E. Mounting Sleeve: Factory- or field-installed galvanized, sheet steel.
 1. Minimum Thickness: 0.052 inch or 0.138 inch thick as indicated, and length to suit application.
 2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized, sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized steel blade connectors.
- H. Horizontal Dampers: Include a blade lock and stainless-steel negator closure spring.
- I. Fusible Link: Replaceable, 165 or 212 deg F rated as indicated.

2.5 CEILING FIRE DAMPERS

- A. General: Labeled to UL 555C; comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."
- B. Frame: 0.040-inch- thick, galvanized, sheet steel; round or rectangular; style to suit ceiling construction.
- C. Blades: 0.034-inch- thick, galvanized, sheet steel with nonasbestos refractory insulation.
- D. Volume Adjustment: UL-labeled, fusible volume-control adjustment.
- E. Fusible Link: Replaceable, 165 deg F rated.
- F. Fusible Link: Replaceable, 212 deg F rated.
- G. Fusible Link: Replaceable, 285 deg F rated.

2.6 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Manufactured Turning Vanes: Fabricate of 1-1/2-inch- wide, curved blades set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into side strips suitable for mounting in ducts.
- C. Acoustic Turning Vanes: Fabricate of airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.7 DUCT-MOUNTED ACCESS DOORS AND PANELS

- A. General: Fabricate doors and panels airtight and suitable for duct pressure class.
- B. Frame: Galvanized, sheet steel, with bend-over tabs and foam gaskets.
- C. Door: Double-wall, galvanized, sheet metal construction with insulation fill and thickness, and number of hinges and locks as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.
- D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- E. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.8 FLEXIBLE CONNECTORS

- A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- B. Standard Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized, sheet steel or 0.032-inch aluminum sheets. Select metal compatible with connected ducts.

- C. Extra-Wide Metal-Edged Connectors: Factory fabricated with a strip of fabric 5-3/4 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized, sheet steel or 0.032-inch aluminum sheets. Select metal compatible with connected ducts.
 - D. Transverse Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches mm) wide attached to two strips of 4-3/8-inch- wide, 0.028-inch- thick, galvanized, sheet steel or 0.032-inch aluminum sheets. Select metal compatible with connected ducts.
 - E. Conventional, Indoor System Flexible Connector Fabric: Glass fabric double coated with polychloroprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp, and 360 lbf/inch in the filling.
 - F. Conventional, Outdoor System Flexible Connector Fabric: Glass fabric double coated with a synthetic-rubber, weatherproof coating resistant to the sun's ultraviolet rays and ozone environment.
 - 1. Minimum Weight: 26 oz./sq. yd.
 - 2. Tensile Strength: 530 lbf/inch in the warp, and 440 lbf/inch in the filling.
 - G. High-Temperature System Flexible Connectors: Glass fabric coated with silicone rubber and having a minimum weight of 16 oz./sq. yd. and tensile strength of 285 lbf/inch in the warp, and 185 lbf/inch in the filling.
 - H. High-Corrosive-Environment System Flexible Connectors: Glass fabric coated with a chemical-resistant coating.
 - 1. Minimum Weight: 14 oz./sq. yd.
 - 2. Tensile Strength: 450 lbf/inch in the warp, and 340 lbf/inch in the filling.
- 2.9 FLEXIBLE DUCTS
- A. General: Comply with UL 181, Class 1.
 - B. Flexible Ducts, Uninsulated: Spiral-wound steel spring with flameproof vinyl sheathing.
 - C. Flexible Ducts, Uninsulated: Corrugated aluminum.
 - D. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2-inch- thick, glass-fiber insulation around a continuous inner liner.
 - 1. Reinforcement: Steel-wire helix encapsulated in inner liner.
 - 2. Outer Jacket: Glass-reinforced, silver Mylar with a continuous hanging tab, integral fibrous-glass tape, and nylon hanging cord.
 - 3. Outer Jacket: Polyethylene film.
 - 4. Inner Liner: Polyethylene film.
 - E. Pressure Rating: 6-inch wg positive, 1/2-inch wg negative.
- 2.10 ACCESSORY HARDWARE
- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments, and length to suit duct insulation thickness.

- B. Splitter Damper Accessories: Zinc-plated damper blade bracket; 1/4-inch, zinc-plated operating rod; and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.
- C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches to suit duct size.
- D. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and NAIMA's "Fibrous Glass Duct Construction Standards" for fibrous-glass ducts.
- B. Internal duct lining shall not be used.
- C. Provide test holes at fan inlet and outlet and elsewhere as indicated.
- D. Install fire and smoke dampers according to manufacturer's UL-approved written instructions.
 - 1. Install fusible links in fire dampers.
- E. Install duct access panels for access to both sides of duct coils. Install duct access panels downstream from volume dampers, fire dampers, turning vanes, and equipment.
 - 1. Install duct access panels to allow access to interior of ducts for cleaning, inspecting, adjusting, and maintaining accessories and terminal units.
 - 2. Install access panels on side of duct where adequate clearance is available.
- F. Label access doors according to Division 23 Section "Mechanical Identification."

3.2 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire and smoke dampers for proper action.
- C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 233300

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Centrifugal roof ventilators.
 - 2. Ceiling-mounting ventilators.
 - 3. In-line centrifugal fans.

1.2 PERFORMANCE REQUIREMENTS

- A. Operating Limits: Classify according to AMCA 99.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
- B. Maintenance Data: For power ventilators to include in maintenance manuals..

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Twin City.
2. Breidert Air Products, Inc
3. Coolair
4. Cook, Loren Company.
5. Greenheck Fan Corp.

2.2 CENTRIFUGAL ROOF VENTILATORS

- A. Description: Direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 3. Fan and motor isolated from exhaust airstream.
- E. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
- F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: Self-flashing without a cant strip, with mounting flange.
 2. Overall Height: 12 inches
 3. Sound Curb: Curb with sound-absorbing insulation matrix.
 4. Pitch Mounting: Manufacture curb for roof slope.
 5. Metal Liner: Galvanized steel.
 6. Hinged Subbase: Galvanized steel hinged arrangement permitting service and maintenance.

7. Mounting Pedestal: Galvanized steel with removable access panel.
8. Vented Curb: Unlined with louvered vents in vertical sides.

2.3 CEILING-MOUNTING VENTILATORS

- A. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
- B. Housing: Steel, lined with acoustical insulation.
- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- D. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories:
 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent.
 2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
 3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
 4. Motion Sensor: Motion detector with adjustable shutoff timer.
 5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
 6. Filter: Washable aluminum to fit between fan and grille.
 7. Isolation: Rubber-in-shear vibration isolators.
 8. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.4 IN-LINE CENTRIFUGAL FANS

- A. Description: In-line, belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
- B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Direct-Driven Units: Motor encased in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

- E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- F. Accessories:
 - 1. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
 - 2. Companion Flanges: For inlet and outlet duct connections.
 - 3. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
 - 4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.5 MOTORS

- A. Refer to Division 23 Section "Motors" for general requirements for factory-installed motors.
- B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.
- C. Enclosure Type: Open dripproof.

2.6 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support units using spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 23 Section "Mechanical Vibration Controls and Seismic Restraints."
 - 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
- C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- D. Secure roof-mounting fans to roof curbs with cadmium-plated hardware.

- E. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- F. Support suspended units from structure using threaded steel rods. Vibration-control devices are specified in Division 23 Section "Mechanical Vibration Controls and Seismic Restraints."
- G. Install units with clearances for service and maintenance.
- H. Label units according to requirements specified in Division 23 Section "Mechanical Identification."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

- A. Starting Procedures:
 - 1. Energize motor and adjust fan to indicated rpm.
 - 2. Measure and record motor voltage and amperage.
- B. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.

3.5 CLEANING

- A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.
- B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power ventilators.

END OF SECTION 233423

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Shutoff, single-duct air terminal units.
- B. This Section includes the following:
 - 1. Pressure independent Single-duct air terminals.
- B. DDC controllers shall be provided by the control vendor and installed by the VAV terminal manufacturer at the factory.
- C. Terminal manufacturer shall include the installation of the DDC controllers, actuator and internal wiring by the factory via a transformer as required to provide a complete installation. Actuators shall be compatible with DDC controller and supplied by the Control Vendor.

1.2 SUBMITTALS

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated. Include a schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished.
- B. Maintenance Data: List of parts for each type of air terminal and troubleshooting maintenance guide to include in the maintenance manuals.

1.3 QUALITY ASSURANCE

- A. NFPA Compliance: Install air terminals according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Comply with NFPA 70 for electrical components and installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide air terminals by one of the following:
 - 1. Nailor Industries

2. Price
3. Metalaire.
4. Trane Co
5. JCI

2.2 SINGLE-DUCT AIR TERMINALS

- A. Configuration: Volume-damper assembly inside unit casing. Locate control components inside protective metal shroud.
- B. Casings: 22 gauge galvanized steel with round or flat oval inlets. Casing leakage downstream of the damper shall not exceed 1% at 1" wg. High side casing leakage shall not exceed 2% at 3" wg.
- C. Casing Lining: Minimum of ¾" thick fiber free closed cell elastomeric foam liner complying with NFPA 90A requirements and UL 181 (25/50 smoke and flame spread).
- D. Damper: Primary air valve shall be constructed of heavy gauge metal with peripheral gasket and solid steel shaft, pivoted in self lubricating bearings. Air leakage past the closed damper shall not exceed 2% at 3" wg.
- E. Air flow sensor: The air flow sensor shall be of a cross configuration. Sensor shall provide accuracy within 5% with a 90° elbow directly at the inlet of the assembly.
- F. Hot-Water Heating Coil: 1/2-inch copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed. **Provide 2-row coil minimum.**
- G. Pressure differential reset controller shall maintain set point (CFM) within 5%, regardless of system pressure change. CFM limiting devices are not acceptable. The reset controller shall constantly monitor thermostat input, air flow (CFM), and system static and total pressures in a manner as to minimize under - or over - controlling in relation to the space temperature requirements. The reset controller shall be capable of field adjustment of minimum and maximum CFM settings without the use of tools. Flow curve for field balancing shall be affixed to terminal casting. Differential flow taps and factory-set CFM shall be provided if so noted at terminal schedule on the drawings. Controller shall maintain pressure independence to as low as .03" w.g.
- H. Terminals shall operate as variable/constant volume terminals. Terminals shall be provided with adjustable maximum and minimum CFM settings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air terminals level and plumb, according to manufacturer's written instructions, rough-in drawings, original design, and referenced standards; and maintain sufficient clearance for normal service and maintenance.

- B. Connect ductwork to air terminals according to Division 23 ductwork Sections.

3.2 CONNECTIONS

- A. Install piping adjacent to air terminals to allow service and maintenance.
- B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Electrical: Comply with applicable requirements in Division 26 Sections.

3.3 FIELD QUALITY CONTROL

- A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

3.5 COMMISSIONING

- A. Check that inlet duct connections are as recommended by air terminal manufacturer to achieve proper performance.
- B. Check that controls and control enclosure are accessible.
- C. Check that nameplate and identification tag are visible.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.

END OF SECTION 233600

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

1.2 DEFINITIONS

- A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.
- B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.
- C. Register: A combination grille and damper assembly over an air opening.

1.3 SUBMITTALS

- A. Product Data: For each model indicated, include the following:
 - 1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
 - 2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
 - 3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
 - 4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.
- B. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.

1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Diffusers, registers, and grilles are scheduled on Drawings.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Metalaire
- b. Nailor Industries Inc
- c. Price
- d. Titus
- e. Krueger

2.2 SOURCE QUALITY CONTROL

- A. Testing: Test performance according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
- B. Install diffusers, registers, and grilles with airtight connection to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.4 CLEANING

- A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 233713

SECTION 234100 - PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.2 DEFINITIONS

- A. HEPA: High-efficiency particulate air.

1.3 SUBMITTALS

- A. Product Data: Include dimensions; shipping, installed, and operating weights; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
- B. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.
 - 1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
- C. Maintenance Data: For each type of filter and rack to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A and NFPA 90B.
- B. ASHRAE Compliance: Comply with provisions of ASHRAE 52.2 for method of testing and rating air-filter units.

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Provide two (2) complete sets of filters for each filter bank.

PART 2 - PRODUCTS

2.1 DISPOSABLE PANEL FILTERS

- A. Description: Factory-fabricated, viscous-coated, pleated type, disposable air filters with holding frames.
- B. Efficiency: 25% to 30% with a MERV 6-7.
- C. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
- D. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.
- E. Duct-Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.
- E. Prefilters: Provide 2" pleated, 30% efficient replacement media prefilters mounted on the face of 2 each high efficiency cartridge and held in place by a hinged gate which is an integral part of the holding frame.

2.2 EXTENDED-SURFACE, DISPOSABLE PANEL FILTERS

- A. Description: Factory-fabricated, dry, extended-surface filters with holding frames. Filters shall be supported by wire grid to prevent sagging.
- B. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
- C. Media and Media-Grid Frame: Galvanized steel.
- D. Duct-Mounting Frames: Welded, galvanized steel with gaskets and fasteners, and suitable for bolting together into built-up filter banks.
- E. 85% Efficiency with a MERV 13 Filters: Each 24 x 24 filter unit shall be rated for 2000 CFM. Initial pressure drop shall be .35" WG. Final pressure drop shall be 1.0" WG. Unit shall consist of high density microfine glass fiber filter media held rigidly in an enclosing frame by a welded wire support grid. Wire grid shall have an effective open area of not less than 96%. Media shall be arranged in pleats so that no less than 14.5 square feet of media is exposed in 1 square foot of unit face area. Media shall be bonded to enclosing frame to prevent air bypass.

2.3 FRONT- AND REAR-ACCESS FILTER FRAMES

- A. Framing System: Aluminum framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters prevent deflection of horizontal members without interfering with either filter installation or operation.

- B. Prefilters: Incorporate a separate track, removable from front or back.
- C. Sealing: Factory-installed, positive-sealing device for each row of filters to ensure seal between gasketed filter elements to prevent bypass of unfiltered air.

2.4 SIDE-SERVICE HOUSINGS

- A. Description: Factory-assembled, side-service housings, constructed of galvanized steel, with flanges to connect to duct system.
- B. Prefilters: Integral tracks to accommodate 2-inch disposable filters.
- C. Access Doors: Continuous gaskets on perimeter and positive-locking devices. Arrange so filter cartridges can be loaded from either access door.
- D. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

2.5 FILTER GAGES

- A. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
 - 1. Diameter: 4-1/2 inches.
- B. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install filter frames according to manufacturer's written instructions.
- B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- C. Install filters in position to prevent passage of unfiltered air.
- D. Install filter gage for each filter bank.
- E. Install filter gage static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gages on outside of filter housing or filter plenum in an accessible position.

3.2 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 234100

SECTION 236423 – AIR COOLED HELICAL ROTARY WATER CHILLERS

1.1 SUMMARY

- A. This Section includes packaged air cooled water chillers with helical rotary compressors.

1.2 SUBMITTALS

- A. Product Data: Include refrigerant; rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated.
- B. Product Certificates: Certification of performance according to ARI 550 and that chillers have been started and function properly.
- C. Maintenance Data: For each chiller to include in maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- B. ASHRAE Compliance: Comply with ASHRAE 15 for chiller design, construction, leak testing, and installation.
- C. ASME Compliance: Comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," for constructing and testing evaporator and condenser pressure vessels. Stamp with ASME label.
- D. UL Compliance: Comply with UL 465.
- E. Comply with NFPA 70.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged air cooled water chillers with protective crating and covering.
- B. Store chillers to prevent damage and protect from weather, dirt, fumes, water, and construction debris.
- C. Handle chillers according to manufacturer's written rigging and installation instructions for unloading, transporting, and setting in final location.

1.5 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and

shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

- B. Manufacturer's Special Warranty on Chiller: Written warranty, signed by manufacturer agreeing to repair or replace any chiller component including compressor, condenser coils and fans, controls, etc. Replacement of refrigerant shall also be included. Note that this is an all inclusive warranty on the entire chiller.
 - 1. Warranty Period: Manufacturer's standard, but not less than five years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Outdoor Air-Cooled Packaged Water Chillers:
 - a. Trane Co.
 - b. Carrier corporation
 - c. Daikin - Mcquay
 - d. York

2.2 COMPRESSORS

- A. Description: Helical rotary type hermetic or serviceable hermetic with, lubrication system, crankcase heater, suction and discharge line service valves, mounted on vibration isolators.
 - 1. Oil Lubrication System: Reversible, positive-displacement pump, strainer, sight glass, filling connection, and filter with magnetic plug.
- B. Refrigerant: 134a full operating charge of refrigerant and oil.

2.3 EVAPORATOR

- A. Description: Direct-expansion, shell-and-tube design with refrigerant in tubes, water in shell, and with removable carbon-steel heads and baffle to ensure oil return.
- B. Tubes: Seamless copper expanded into tube sheets.
 - 1. Refrigerant Working Pressure: 300 psig.
 - 2. Water-Side Working Pressure: 200 psig.

- C. Insulation: Factory applied to evaporator, suction lines, and other surfaces where condensation might occur, with 3/4-inch- thick, flexible elastomeric insulation.
- D. Evaporator Heater: Factory-installed electric heater with capacity to protect evaporator to minus 20 deg F ambient temperature.
- E. Flow Switches: Provide flow switches interlocked to prevent unit operation upon loss of flow.

2.4 REFRIGERANT CIRCUIT ACCESSORIES

- A. Multiple refrigerant circuits, each with the following specialties:
 - 1. Suction and discharge shutoff valves.
 - 2. Refrigerant charging connection.
 - 3. Hot-gas muffler.
 - 4. Solenoid valve in liquid line.
 - 5. Filter/dryer with replaceable core.
 - 6. Sight glass and moisture indicator in liquid line.
 - 7. Pressure-relief valve.
 - 8. Thermal or electronic expansion valve.

2.5 AIR-COOLED CONDENSER

- A. Exterior Casing: Manufacturer's standard equipment casing coated with corrosion-resistant exterior finish and with removable doors or panels for service and inspection.
- B. Coils: Seamless copper tubing mechanically jointed to aluminum fins. Factory test coils for leaks to minimum test pressure of 425 psig.
- C. Coil Protection: Louvered panels to cover the complete condensing coil and coated wire mesh for the evaporator/service area below.
- D. Fans: Direct drive, statically and dynamically balanced, with fan guards.
- E. Fan Motors: Integral overload protection, and permanently lubricated bearings.

2.6 CONTROL PANEL

- A. Manufacturer's standard microprocessor-based chiller controls; remote mounted, and factory wired with a single-point power connection and separate control circuit.
 - 1. HACR Circuit Breaker: Provide molded case circuit breaker arranged to provide overcurrent protection as well as a service disconnect.
- B. Status Display: Include the following conditions:
 - 1. Date and time.

2. Operating or alarm status.
 3. Operating hours.
 4. Entering-chilled-water temperature.
 5. Leaving-chilled-water temperature.
 6. Evaporator refrigerant temperature.
 7. Evaporator pressure.
 8. Condenser pressure.
 9. Electronic expansion valve position.
 10. Control set points.
- C. Control Functions: Include the following:
1. Manual or automatic startup and shutdown time schedule.
 2. Leaving-chilled-water temperature reset from entering-chilled-water temperature.
 3. Antirecycling timing-out to prevent rapid compressor cycling.
 4. Automatic lead-lag switching.
 5. Start and run during low ambient air temperature.
- D. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:
1. Refrigerant low pressure.
 2. Evaporator low temperature.
 3. Refrigerant high pressure.
 4. Low oil flow or pressure.
 5. No chilled-water flow.
 6. Control device failure.
 7. Low control voltage.
 8. Compressor motor current-overload protection.
- E. Building Management System Interface: Factory-installed LonTalk Interface Communications Interface hardware and software to enable building management system to monitor and control chilled-water set point and chiller-control displays and alarms.
1. Chiller Inputs
 - a. Chiller Enable/disable.
 - b. Chiller Water Setpoint
 - c. Current Limit Setpoint
 2. Chiller Outputs
 - a. On/Off.
 - b. Active Setpoint
 - c. Average Percent RLA

- d. Active Current Limit Setpoint
- e. Leaving Chilled Water Temperature
- f. Entering Chilled Water Temperature.
- g. Alarm Description.
- h. Chiller Status

2.7 MOTOR STARTER

- A. Power Controls: Combination controller and disconnect with Wye-Delta starting.

2.8 SINGLE POINT POWER CONNECTION

- A. Power connection: single Point

2.9 CONVENIENCE OUTLET

- A. Convenience outlet: 15 ampere, 120 volt, prewired convenience outlet

2.10 LOW AMBIENT OPERATION:

- A. Provide controls and devices including head pressure controls and condenser fan control required for low ambient operation to 10°F.

2.11 VIBRATION CONTROL

- A. Direct isolation (no base) and the following vibration isolators:
 - 1. Vibration Isolators: Manufacturers standard neoprene pads.

2.12 ACOUSTIC TREATMENT:

- A. Provide factory sound baffles and attenuation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive chillers for compliance with requirements for installation tolerances and other conditions affecting chiller performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in piping and electrical connections.

3.2 INSTALLATION

- A. Install chillers level and plumb, and anchor to base.
- B. Maintain manufacturer's recommended clearances for service and maintenance.
- C. Electrical Wiring: Install electrical components, devices, and accessories furnished loose by manufacturer, including remote flow switches and remote chiller control panel.

3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements. Install piping adjacent to machine to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and chiller installation, including piping and electrical connections. Report results in writing.

3.5 CLEANING

- A. After completing installation, including outlet fittings and devices, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

3.6 COMMISSIONING

- A. Verify that installation complies with the Contract Documents.
- B. Engage a factory-authorized service representative to perform startup service.
 - 1. Fill out startup checklists and attach copy with Contractor Startup Report.
- C. Complete installation and startup checks according to manufacturer's written instructions and check for the following items:
 - 1. No physical damage to unit.
 - 2. Unit is level.
 - 3. Chiller vibration isolation and flexible pipe connections are installed.
 - 4. Clearances have been maintained and piping is installed for easy removal for service and tube cleaning.
 - 5. Chilled-water pipes have been connected to correct ports.
 - 6. Labels and safety instructions are clearly visible.
 - 7. Oil levels are as recommended by manufacturer.

8. Refrigerant charge is sufficient and chiller has been leak tested.
 9. Shipping skids, blocks, and straps are removed.
 10. Refrigerant pressure relief is vented to outside.
 11. Thermometers and pressure gages are installed.
 12. Controls and safety interlocks are installed and connected.
 13. Pumps are installed, connected, and operational.
- D. Check and record performance of chiller protection devices.
- E. Check and record performance of chilled-water flow and low-temperature interlocks.
- F. Operate chiller for run-in period as recommended by manufacturer.
- G. Check refrigerant charge. Check oil level.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers as specified below:
1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining chillers.
 2. The training shall be provided for 8 hours per person for a total of 10 people.

END OF SECTION 236423

SECTION 237313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes constant-volume and variable volume, central-station air-handling units with coils for indoor installations.

1.2 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each central-station air-handling unit specified, including the following:
 - 1. Certified fan-performance curves with system operating conditions indicated.
 - 2. Certified fan-sound power ratings.
 - 3. Certified coil-performance ratings with system operating conditions indicated.
 - 4. Motor ratings and electrical characteristics plus motor and fan accessories.
 - 5. Material gages and finishes.
 - 6. Filters with performance characteristics.
 - 7. Dampers, including housings, linkages, and operators.
- C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loading, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.
- E. Coordination Drawings, including floor plans and sections drawn to scale. Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- F. Field test reports indicating and interpreting test results relative to compliance with specified requirements.
- G. Maintenance data for central-station air-handling units to include in the operation and maintenance manual.

1.3 QUALITY ASSURANCE

- A. NFPA Compliance: Central-station air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
- B. UL Compliance: Central-station air-handling unit, shall be listed and labeled by UL.
- C. ARI Certification: Central-station air-handling units and their components shall be factory tested according to the applicable portions of ARI 430, "Central-Station Air-Handling Units," and shall be listed and bear the label of the Air-Conditioning and Refrigeration Institute (ARI).
- D. UL and NEMA Compliance: Provide motors required as part of air-handling units that are listed and labeled by UL and comply with applicable NEMA standards.
- E. Comply with NFPA 70 for components and installation.
- F. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- G. Coordination: Coordinate layout and installation of central-station air-handling units with piping and ductwork and with other installations.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver air-handling unit as a factory-assembled module with protective crating and covering.
- B. Lift and support units with manufacturer's designated lifting or supporting points.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate size and location of concrete housekeeping bases. Cast anchor-bolt inserts into base.
- B. Coordinate size and location of structural-steel support members.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
- B. Filters: Furnish 2 sets for each central-station air-handling unit.
- C. Fan Belts: Furnish 1 set for each central-station air-handling unit fan.

- D. Gaskets: Furnish 1 for each sectional joint of each central-station air-handling unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Corp.; Carrier Air Conditioning Div.
 - 2. JCI (York)
 - 3. Trane Company (The); Commercial Systems Group.
 - 4. Daikin - McQuay

2.2 MANUFACTURED UNITS

- A. General Description: Factory assembled modular, 2 " thick double wall units consisting of fans, motor and drive assembly, coils, damper, plenums, filters, drip pans, and mixing dampers.
- B. Motor and Electrical Components: Refer to Division 23 Section "Motors."

2.3 CABINET

- A. Unit shall be constructed of a frame with removable formed and reinforced G90 galvanized steel panels fabricated to allow removal for access to internal parts and components. Construction shall permit removal of the panels without affecting the structural integrity of the unit. Panels shall be 2 inch thick double wall construction with solid inner and outer skin.. Exterior casing shall be constructed of a minimum of 16 gauge G90 galvanized steel. The interior lining shall be a solid lining of 20 gauge G90 galvanized steel. Casing shall be able to withstand up to 6" of positive and 4" of negative static pressure.
- B. Base Rail: Entire unit shall be provided with a full length base rail channel formed of galvanized steel.
- C. Insulation: Coated, glass-fiber insulation, complying with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," for insulation.
 - 1. 2" thick 1½ lb. Density with R value of 7.69.
- D. Access Panels and Doors: Double walled G90 galvanized steel panels with neoprene gasketing, with two position ventlock style latches operable from the interior and exterior of the unit. Same materials and finishes as cabinet and complete with hinges,

latches, handles, and gaskets. A view window made of double pane glass with safety glass reinforcement in doors shall be provided.

1. Each section shall have inspection and access panels and doors sized and located to allow periodic maintenance and inspections.
- E. Drain Pans: Insulated, double walled stainless steel, 2 way sloping IAQ drain pan to allow for proper condensate removal. Fabricate pans in sizes and shapes to collect condensate from cooling coils (including coil piping connections and return bends) and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.
1. Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil.
- J. Provide spacer section with inspection access door between coils.

2.4 FAN SECTION

- A. Fan-Section Construction: Belt-driven centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure, equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels. Mount fan scroll, wheel, shaft, bearings, and motor on structural-steel frame, with frame mounted on base with vibration isolation.
- B. Housings: Fabricate from formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff, spun-metal inlet bell, and access doors or panels to allow entry to internal parts and components.
- C. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor power. Fan wheel shall be double-width, double-inlet type with backward-curved airfoil blades as indicated.
1. Plug Fans: Fabricate without fan scroll and volute housing, with steel cabinet.
 2. Backward Inclined: Steel or aluminum construction with curved inlet flange, back plate, backward-curved blades, and cast-iron or cast-steel hub.
 3. Airfoil Wheel: Steel; with smooth, curved inlet flange; back plate; die-formed, hollow, airfoil blades; and cast-iron or cast-steel hub.
 4. Shafts: Hot-rolled steel; turned, ground, and polished, and having keyway to secure to fan wheel hub.
 5. Shaft Bearings: Self-aligning, pillow-block-type ball or roller bearings with the following:
 - a. Rated Bearing Life: ABMA 9 or ABMA 11, L-50 of 200,000 hours.
 6. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - a. Service Factor Based on Fan Motor: 1.5.

7. Pulleys: Cast iron or steel with split, tapered bushing, dynamically balanced at factory.
8. Motor Pulleys: Adjustable pitch, selected so pitch adjustment is at middle of adjustment range at fan design conditions. Suitable for adjustment within plus or minus 5% of selected rpm.
9. Belts: Oil resistant, nonsparking, and nonstatic; matched for multiple belt drives.
10. Belt Guards: Fabricate to OSHA/SMACNA requirements, 0.1046 inch thick, 3/4-inch diamond-mesh wire screen welded to steel angle frame or equivalent, galvanized.
11. Motor Mount: Adjustable for belt tensioning.
12. Accessories: Provide the following where shown on the drawings:
 - a. Variable frequency drives.
 - b. Discharge dampers.
13. Vibration Control: Fan and motor assembly shall be internally isolated from the unit casing with housed 2 inch deflection spring isolators.

D. Fan-Section Source Quality Control: The following factory tests are required.

1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
2. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

2.5 MOTORS

- A. General: Refer to Division 23 Section "Motors" for general requirements.
- B. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
- C. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range.
- D. Temperature Rating: 50 deg C maximum temperature rise at 40 deg C ambient for continuous duty at full load (Class A Insulation).
- E. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
- F. Motor Construction: NEMA MG-1, general purpose, continuous duty, Design B.
 1. Bases: Adjustable.
- G. Bearings: The following features are required:
 1. Ball or roller bearings with inner and outer shaft seals.
 2. Grease lines extended to the fan support bracket on the drive side..

- H. Enclosure Type: The following features are required:
 - 1. Open dripproof motors where satisfactorily housed or remotely located during operation.
- I. Overload Protection: Built-in, automatic reset, thermal overload protection.
- J. Noise Rating: Quiet.
- K. Nameplate: Indicate full identification of manufacturer, ratings, characteristics, construction, and special features.

2.6 COILS

- A. Coil Sections: Common or individual, insulated, galvanized steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to assure full airflow through coils.
- B. Coil Construction: Rigidly supported across full face, pitched to allow drainage.
 - 1. Fins: Aluminum, mechanically bonded to tubes.
 - 2. Tubes: Seamless copper.
 - 3. Coil Casing:
 - a. Galvanized steel.
 - b. Stainless steel on makeup air units.
- C. Water Coils: Drainable with threaded plugs, serpentine with return bends in smaller sizes and with return headers in larger sizes.
- D. Coil-Performance Tests: Factory-test cooling and heating coils for rating according to ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils."

2.7 DAMPERS

- A. General: Leakage rate, according to AMCA 500, "Test Methods for Louvers, Dampers and Shutters," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.
- B. Mixing Boxes: Parallel-blade galvanized steel damper blades mechanically fastened to steel operating rod in reinforced, galvanized steel cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
- C. Combination Filter/Mixing Box: Parallel-blade galvanized steel damper blades mechanically fastened to steel operating rod in reinforced, galvanized steel cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously. Cabinet support members shall hold 2-inch- thick, pleated, flat permanent or throwaway filters. Provide hinged access panels or doors to allow removal of filters from both sides of unit.

2.8 FILTER SECTION

- A. Air Filters: Refer to Division 23 Section "Air Filters."
- B. Filter Section: Provide filter media holding frames arranged for flat or angular orientation, with access doors on both sides of unit.
- C. Provide one (1) set for start up and one (1) set for future.

1.7 MARINE LIGHTS:

- A. Marine lights: Factory mounted, enclosed and gasketed, vapor tight incandescent light fixtures shall be provided in the fan module and access modules. Fixtures shall be complete with junction box, globe, aluminum guard, receptacle and long life bulb. Lights shall be wired to individual switches with a convenience outlet (receptacle) located at each switch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions to receive equipment, for compliance with installation tolerances and other conditions affecting performance of central-station air-handling units.
- B. Examine roughing-in of steam, hydronic, condensate drainage piping, and electrical to verify actual locations of connections before installation.
- C. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install central-station air-handling units level and plumb, according to manufacturer's written instructions.
 - 1. Floor-Mounted Units: Support on concrete housekeeping bases. Secure units to anchor bolts installed in concrete housekeeping base.
 - 2. Suspended Units: Suspend units from structural-steel support frame using threaded steel rods and vibration isolation.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

3.3 HOUSEKEEPING BASES

- A. Coordinate size of housekeeping bases with actual unit sizes provided. Construct base 4 inches larger in both directions than overall dimensions of supported unit.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connection piping to air-handling units with flexible connectors.
 - 3. Connect condensate drain pans using 1-1/4-inch NPS, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
 - 4. Hot- and Chilled-Water Piping: Conform to applicable requirements of Division 23 Section "Hydronic Piping." Connect to supply and return coil tapplings with shutoff or balancing valve and union or flange at each connection.
- B. Duct installation and connection requirements are specified in other Division 23 Sections. The Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.
- C. Electrical: Conform to applicable requirements of Division 26 Sections.
 - 1. Connect fan motors to wiring systems and to ground. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
 - 2. Temperature control wiring and interlock wiring is specified in Division 23 Section "Control Systems Equipment."

3.5 CLEANING

- A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- B. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

3.6 COMMISSIONING

- A. Final Checks before Startup: Perform the following before startup:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.
 - 3. Perform cleaning and adjusting specified in this Section.
 - 4. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 - 5. Comb coil fins for parallel orientation.

6. Install clean filters.
 7. Verify that manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in fully open position.
- B. Starting procedures for central-station air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
 - a. Replace fan and motor pulleys as required to achieve design conditions.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for air-handling system testing, adjusting, and balancing.

3.7 DEMONSTRATION

- A. Engage the services of a factory-authorized service representative to train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.

END OF SECTION 237313

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves for raceways and cables.
 - 2. Supporting devices for electrical components.
 - 3. Electrical identification.
 - 4. Cutting and patching for electrical construction.
 - 5. Sleeve seals.
 - 6. Grout.
 - 7. Common electrical installation requirements.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. LFMC: Liquidtight flexible metal conduit.
- D. RNC: Rigid nonmetallic conduit.
- E. RMC Rigid metal conduit
- F. AHJ: Authority Having Jurisdiction

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.5 INSPECTIONS

- A. It is the responsibility of the electrical contractor to notify the engineer and local electrical inspections department to schedule all required inspections including rough-in, above ceiling and final inspections.

1.6 SUBMITTALS

- A. Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, and identification materials and devices.
- B. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
- C. Samples: Of color, lettering style, and other graphic representation required for each identification material and device.

1.7 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
- B. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- C. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- D. Coordinate electrical service connections to components furnished by utility companies.
- E. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
- F. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- G. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.
- H. Check, verify and coordinate work with other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with the building structure or other trades.
- I. Drawings and specifications are necessarily schematic in nature and cannot describe completely all situations that might be encountered in the field. It is the responsibility of the contractor to familiarize himself with the scope of work required and include all work indicated or reasonably implied by the contract documents.
- J. Work not covered in the Contract Documents will be required if it is reasonably inferable as being necessary to produce the results intended by the Contract

documents for a completed project to the level of quality consistent with the nature and standard of such work shown by the Drawings and Specifications.

- K. Layout the work to prevent conflict with, and to coordinate with work of other trades. Systems shall generally be run in a rectilinear fashion.
- L. Each trade is responsible for the coordination of their work with all other work at the site prior to beginning in each area.
- M. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- N. Coordinate space requirements, supports, and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- O. After owner occupancy of premises, coordinate access to site directly with owner for correction of defective work and work not in accordance with the contract documents, to minimize disruption of owner activities. Contractors will be backcharged for any additional security that is necessary to complete the work.

1.8 DIVISION OF WORK (Division 23/26)

- A. This section delineates the division of work between Division 23 and Division 26.
- B. Specific work to be done under Division 26 is hereinafter listed or described. All other work necessary for the operation of Division 23 equipment shall be performed under Division 23.
- C. All individual motor starters for mechanical equipment (fans, pumps, etc.) shall be furnished and installed under Division 23 unless indicated as a part of a motor control center. Motor starters for mechanical equipment provided in motor control centers shall be furnished under Division 26.
- D. Under Division 26, power wiring shall be provided up to a termination point consisting of a junction box, trough, starter or disconnect switch. Under Division 26 line side terminations shall be provided. Wiring from the termination point to the mechanical equipment, including final connections, shall be provided under Division 23.
- E. Duct smoke detectors shall be furnished and wired by Division 26, installed by Division 23. Fire alarm AHU shut down circuits shall be wired from the fire alarm control panel to a termination point, adjacent to the AHU control, under Division 26. AHU control wiring from the termination point to the equipment shall be under Division 23.
- F. All relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric, and electric-pneumatic switches, aquastats, freezestats, line and low voltage thermostats, thermals, remote selector switches, remote pushbutton

stations, emergency break-glass stations, interlocking, disconnect switches beyond termination point, and other appurtenances associated with equipment under Division 23 shall be furnished, installed and wired under Division 23 unless otherwise noted on plans.

- G. All wiring required for controls and instrumentation not indicated on the drawings shall be furnished and installed by Division 23.
- H. Roof exhaust fans with built-in disconnects provided under Division 23 shall be wired under Division 26 to the line side of the disconnect switch. A disconnect switch shall be provided under Division 26 if the fan is not provided with a built-in disconnect switch. In this case wiring from the switch to the fan shall be under Division 23.
- I. The sequence of control for all equipment shall be as indicated on the Division 23 Drawings and specified in Section, HVAC Control System.
- J. All sprinkler flow and tamper switches shall be furnished and installed under Division 15, and wired under Division 26.
- K. Where electrical wiring is required by trades other than covered by Division 26, specifications for that section shall refer to same wiring materials and methods as specified under Division 26. No Exceptions.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch-diameter slotted holes at a maximum of 2 inches o.c., in webs.
- D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- E. Expansion Anchors: Carbon-steel wedge or sleeve type.
- F. Toggle Bolts: All-steel springhead type.

2.2 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.3 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Stainless steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.4 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.
- F. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- G. Raceways Exposed to Different Temperatures.
 - 1. Sealing. Where portions of a cable raceway or sleeve are known to be subjected to different temperatures and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway or sleeve shall be filled with an approved material to prevent the circulation of warm air to a colder section of the raceway or sleeve.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.
- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.3 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- G. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- H. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.
- I. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- J. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- K. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
 - 1. Wood: Fasten with wood screws or screw-type nails.
 - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 - 3. New Concrete: Concrete inserts with machine screws and bolts.
 - 4. Existing Concrete: Expansion bolts.
 - 5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.
 - 6. Steel: Welded threaded studs or spring-tension clamps on steel.
 - a. Field Welding: Comply with AWS D1.1.
 - 7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
 - 8. Light Steel: Sheet-metal screws.
 - 9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 6 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations,

unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement.

3.5 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.6 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.7 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.8 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly.

3.9 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 260500

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 BUILDING WIRES AND CABLES

- A. UL-listed building wires and cables shall be 600 V, unless otherwise noted, color code conductors for low voltage (secondary feeders and branch circuits) as required by code.
- B. Insulation for all interior conductors shall be dual rated THHN/THWN, or XHHW single conductor.
- C. Conductor Material: Copper.
- D. Stranding: Solid conductor for No. 10 AWG and smaller; Class B stranded conductor for No. 8 AWG and larger.
- E. Power and lighting circuits minimum conductor size allowed is No. 12 AWG.
- F. Largest conductor size allowed is 500 Kcmil unless otherwise noted on plans.

- G. Control wiring shall have stranded conductors.
- H. Lighting fixture whips shall be THHN/THWN conductors in flexible metal conduit, ½" minimum trade size.
- I. Provide a dedicated neutral conductor with each branch circuit. No shared neutrals allowed.

2.2 CONNECTORS AND SPLICES

- A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."
- B. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- C. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. No more than one of each phase conductor A, B and C with the associated neutral(s) and ground conductor(s) shall be pulled in any common raceway.
- E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- F. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- G. Seal around cables penetrating fire-rated elements.
- H. Identify wires and cables according to Division 26 Section "Basic Electrical Materials and Methods."

- I. Secondary Service, Feeder, and Branch-Circuit Conductors: Color-code throughout the secondary electrical system.

3.3 VOLTAGE DROP

- A. Where the conductor length from the panel to the first outlet on a 277 volt system exceeds 125 feet, the minimum branch circuit conductor size shall not be smaller than No. 10 AWG.
- B. Where the conductor length from the panel to the first outlet on a 120 volt system exceeds 50 feet, the minimum branch circuit conductor size shall not be smaller than No. 10 AWG**
- C. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

3.4 CONNECTIONS

- A. Conductor Splices: Keep to minimum. All conductors shall be continuous from outlet to outlet. No splices shall be made except within junction boxes, troughs and gutters.
- B. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
- C. Use splice and tap connectors compatible with conductor material.
- D. Joints in solid conductors shall be spliced using "Ideal" wirenuts, 3M Company "Scotchlock" or T&B "Piggy" fasteners.
- E. Joints in stranded conductors shall be spliced by approved mechanical connectors and gum rubber tape or friction tape. Solderless mechanical connectors for splices and taps, provided with UL approved insulating covers may be used instead of mechanical connectors plus tape.
- F. Sta-kon or other permanent type crimped connectors shall not be used for branch circuit connections.

3.5 FIELD QUALITY CONTROL

- A. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

- B. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Grounding arrangements and connections for separately derived systems.
 - 4. Grounding for sensitive electronic equipment.
- C. Qualification Data: For testing agency and testing agency's field supervisor.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
 - 1. Instructions for periodic testing and inspection of grounding features at test wells and grounding connections for separately derived systems based on NETA MTS and NFPA 70B.
 - a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
 - b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."
- B. Equipment Grounding Conductors: Insulated with green-colored insulation.
- C. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- D. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators.
- E. Bare Copper Conductors: Comply with the following:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Assembly of Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.

2.2 CONNECTOR PRODUCTS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel 3/4 inch by 10 feet (19 mm by 3 m) in diameter. Minimum of three driven ground rods.
- B. Building Steel
- C. All metallic cold water pipes entering the building including those for domestic cold water and fire sprinkler service.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches (600 mm) below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated. Bond to grounding electrode system at cold water pipe entrance or electrical service entrance.
 - 1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits. No circuit shall be without an equipment grounding conductor. The conduit shall not serve as the equipment grounding conductor.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus unless otherwise noted on drawings.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.
 1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:
 1. All Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building including but not limited to domestic cold water and fire sprinkler service pipe. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

- B. Perform the following tests and inspections and prepare test reports:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 - 3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Report measured ground resistances that exceed the following values:
 - 1. 25 ohms.
- D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring and other building systems..
 - 1. Raceways include the following:
 - a. EMT: Electrical metallic tubing.
 - b. FMC: Flexible metal conduit.
 - c. LFMC: Liquidtight flexible metal conduit.
 - d. LFNC: Liquidtight flexible nonmetallic conduit.
 - e. RMC: Galvanized Rigid steel conduit.
 - f. RNC: Rigid nonmetallic conduit.
 - g. MC Cable (Restricted Use – See installation details below)
 - h. Wireways
 - 2. Boxes, enclosures, and cabinets include the following:
 - a. Device boxes.
 - b. Floor boxes.
 - c. Outlet boxes.
 - d. Pull and junction boxes.
 - e. Cabinets and hinged-cover enclosures.

1.2 SUBMITTALS

- A. Product Data: For wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.3 QUALITY ASSURANCE

- A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.
- B. Comply with NECA's "Standard of Installation."
- C. Comply with NFPA 70.

1.4 COORDINATION

- A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Galvanized Rigid Steel Conduit: ANSI C80.1.
- B. EMT and Fittings: ANSI C80.3. with plated steel hexagonal compression type fittings with insulated throats. Fittings installed in concrete or masonry shall be "concrete tight". Fittings installed in damp locations shall be "rain tight".
- C. FMC: Zinc-coated steel.
- D. LFMC: Liquidtight Flexible steel conduit with PVC jacket.
- E. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

2.2 METAL WIREWAYS

- A. Material: Sheet metal sized and shaped as indicated.
- B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Wireway Covers: Hinged type.
- D. Finish: Manufacturer's standard enamel finish.

2.3 OUTLET AND DEVICE BOXES

- A. Sheet Metal Boxes: NEMA OS 1.
- B. Cast-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.

2.4 FLOOR BOXES

- A. Floor Boxes: Cast metal, fully adjustable, two compartment, power and data, rectangular with mop resistant brass cover and plug.

2.5 PULL AND JUNCTION BOXES

- A. Small Sheet Metal Boxes: NEMA OS 1.
- B. Cast-Metal Boxes: NEMA FB 1, with gasketed cover.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS

- A. Outdoors: Use the following wiring methods:

1. Galvanized Rigid Steel.
2. Underground, RNC.
3. Connection to Vibrating Equipment LFMC.
4. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.

- B. Indoors: Use the following wiring methods:

1. Exposed: Below 8 feet above the floor: Galvanized Rigid Steel.
2. Exposed: Above 8 feet above the floor: EMT with compression fittings..
3. Concealed: EMT with compression fittings.
4. Connection to Vibrating Equipment: FMC; except in wet or damp locations, use LFMC.
5. Damp or Wet Locations: Galvanized Rigid Steel conduit.
6. Lighting fixture whips: FMC
7. Boxes and Enclosures: NEMA 250, Type 1.
8. MC Cable: Where concealed and not subject to physical abuse. May only be used for branch wiring to receptacles and other 120 volt devices. The primary homerun circuit from the panelboard to a junction box in the room containing the devices shall be in EMT. MC cable only may be used for the branch wiring from the junction box to the device. Branch circuits for kitchen circuits shall be in conduit complete.

3.3 INSTALLATION

- A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
- B. Minimum Raceway Size: 3/4-inch trade size, except 1" minimum for telecom/data outlets.
- C. In finished areas of the Building, conceal conduit unless otherwise indicated, within finished walls, ceilings, and floors.
- D. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- E. Install raceways level and square and at proper elevations. Provide adequate headroom.
- F. Raceways Embedded in Slabs: Install in middle third of slab thickness where practical, and leave at least 1-inch concrete cover.

- G. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
- H. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.
- I. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to the above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
- J. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.
- K. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semi recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

3.4 UNDERGROUND RACEWAYS

- A. Underground Raceways run external to building foundation walls, with the exception of branch circuit raceways, shall be encased with a minimum of three (3) inches of concrete on all sides.
- B. Encased raceways must have a minimum cover of eighteen (18) inches, except for raceways containing circuits with voltages above 600 volts, which must have a minimum cover of thirty (30) inches.
- C. All underground raceways shall be identified by underground line marking tape located directly above the raceway at 6 to 8 inches below finished grade. Tape shall be permanent, bright-colored, continuous printed, plastic tape compounded for direct burial not less than 6 inches wide and 4 mils thick. Printed legend shall be indicative of general type of underground line below.
- D. Where underground raceways are required to turn up into cabinets, equipment, etc., and on to poles, the elbow required and the stub-up out of the slab or earth shall be of rigid steel.
- E. The raceway system shall not be relied on for grounding continuity.

3.5 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.6 CLEANING

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260533

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.2 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

- A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
1. Color: Black letters on orange field.
 2. Legend: Indicates voltage and service.
- B. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.
- C. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.

1. Not less than 6 inches wide by 4 mils thick.
 2. Compounded for permanent direct-burial service.
 3. Embedded continuous metallic strip or core.
 4. Printed legend indicating type of underground line.
- D. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- E. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch- thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- F. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.
- G. Aluminum-Faced, Card-Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inch thick, laminated with moisture-resistant acrylic adhesive, punched for fasteners, and preprinted with legends to suit each application.
- H. Brass or Aluminum Tags: 2 by 2 by 0.05-inch metal tags with stamped legend, punched for fastener.

2.2 NAMEPLATES AND SIGNS

- A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes. Letters shall be 1/2" high minimum and the nameplate material colors shall be as follows:
1. Blue surface with white core for 120/208 volt equipment.
 2. Black surface with white core for 277/480 volt equipment.
 3. Bright red surface with white core for all equipment related to fire alarm system.
 4. Dark red (burgundy) surface with white core for all equipment related to security.
 5. Green surface with white core for all equipment related to "emergency" systems.
 6. Orange surface with white core for all equipment related to telephone systems.
 7. Brown surface with white core for all equipment related to data systems.
 8. White surface with black core for all equipment related to paging systems.
 9. Purple surface with white core for all equipment related to TV systems.
- C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.
- D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.

- E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength: 50 lb minimum.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: According to color-coding.
- B. Paint: Formulated for the type of surface and intended use.
 - 1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
 - 2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
 - 3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
 - 4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
 - 1. Circuits with More Than 600 V: Identify raceway and cable with "DANGER--HIGH VOLTAGE" in black letters 2 inches high, stenciled with paint at 10-foot intervals over a continuous, painted orange background.
- C. Install painted identification according to manufacturer's written instructions and as follows:
 - 1. Clean surfaces of dust, loose material, and oily films before painting.
 - 2. Prime surfaces using type of primer specified for surface.
 - 3. Apply one intermediate and one finish coat of enamel.
- D. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
 - 1. Bands: Pretensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches wide, completely

- encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
- 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- 3. Apply the following colors to the systems listed below:
 - a. Fire Alarm System: Red.
 - b. Fire-Suppression Supervisory and Control System: Red and yellow.
 - c. Combined Fire Alarm and Security System: Red and blue.
 - d. Security System: Blue and yellow.
 - e. Mechanical and Electrical Supervisory System: Green and blue.
 - f. Telecommunication System: Green and yellow.
- E. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.
- F. Circuit Identification Labels on Boxes: Install labels externally.
 - 1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
 - 2. Concealed Boxes: Plasticized card-stock tags.
 - 3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
 - 4. All receptacle and light switch cover plates shall have circuit identification label neatly applied to the device cover plate.
- G. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single line marker.
- H. Secondary Service, Feeder, and Branch-Circuit Conductors: Color-code throughout the secondary electrical system.
 - 1. Color-code 208/120-V system as follows:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - e. Ground: Green.
 - 2. Color-code 480/277-V system as follows:
 - a. Phase A: Brown
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Natural gray.
 - e. Ground: Green.

3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
 - a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch- wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
 - b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.
- I. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.
 1. Legend: 1/4-inch- steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
 2. Tag Fasteners: Nylon cable ties.
 3. Band Fasteners: Integral ears.
- J. Apply warning, caution, and instruction signs as follows:
 1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.
- K. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch- high lettering on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high. Use nameplate colors specified in paragraph 2.2B. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
 1. Panelboards, electrical cabinets, and enclosures.
 2. Access doors and panels for concealed electrical items.
 3. Electrical switchgear and switchboards.
 4. Emergency system boxes and enclosures.
 5. Disconnect switches.
 6. Enclosed circuit breakers.
 7. Motor starters.
 8. Push-button stations.
 9. Power transfer equipment.

10. Contactors.
11. Control devices.
12. Transformers.
13. Power-generating units.
14. Telephone switching equipment.
15. Fire alarm master station or control panel.

END OF SECTION 260553

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Indoor occupancy sensors.
 - 2. Lighting contactors.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Lighting.
 - 2. Sensor Switch, Inc.
 - 3. Watt Stopper (The).
 - 4. Leviton.
- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
 - 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

2. All occupancy sensors shall be dual technology, extended range type.
 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 4. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 6. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 7. Bypass Switch: Override the on function in case of sensor failure.
 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.
- C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot- high ceiling.

2.2 LIGHTING CONTACTORS

- A. Description: Electrically operated and mechanically held, combination type complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
- B. All exterior lighting circuits to be routed through a lighting contactor to be installed in the main ground level electrical room. Contactor shall be controlled by a single photo cell installed in an inconspicuous exterior location not impacted by ambient light. A maintenance by-pass switch shall be installed in parallel with the photo cell and adjacent to the lighting contactor. Provide and install a contactor having poles equal to the number of exterior lighting circuits noted on plans plus 2.

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaries controlled by occupancy sensors at each sensor.
- B. Label contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.

2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.

END OF SECTION 260923

SECTION 262200 - DRY-TYPE TRANSFORMERS (1000 V AND LESS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes dry-type distribution and specialty transformers rated 1000 V and less.

1.3 SUBMITTALS

- A. Product Data: Include data on features, components, ratings, and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.
- B. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.
- C. Product Certificates: Signed by manufacturers of transformers certifying that the products furnished comply with requirements.
- D. Maintenance Data: For transformers to include in the maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Listing and Labeling: Provide transformers specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with IEEE C2.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide transformers by one the following:
 - 1. GE Electrical Distribution & Control.
 - 2. Square D; Groupe Schneider.
 - 3. Siemens
 - 4. Cutler Hammer

2.2 TRANSFORMERS, GENERAL

- A. Description: Factory-assembled and -tested, air-cooled units of types specified, designed for 60-Hz service.
- B. Cores: Grain-oriented, nonaging silicon steel.
- C. Coils: Continuous windings without splices, except for taps.
- D. Internal Coil Connections: Brazed or pressure type.
- E. Enclosure: Class complies with NEMA 250 for the environment in which installed.

2.3 GENERAL-PURPOSE DISTRIBUTION AND POWER TRANSFORMERS

- A. Comply with NEMA ST 20 and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Windings: One coil per phase in primary and secondary.
- D. Enclosure: Indoor, ventilated.
- E. Insulation Class: 185 or 220 deg C class for transformers 15 kVA or smaller; 220 deg C class for transformers larger than 15 kVA.
 - 1. Rated Temperature Rise: 80 deg C maximum rise above 40 deg C.
- F. Taps: For transformers 3 kVA and larger, full-capacity taps in high-voltage windings are as follows:
 - 1. Taps, 3 through 10 kVA: Two 5-percent taps below rated high voltage.
 - 2. Taps, 15 through 500 kVA: Six 2.5-percent taps, 2 above and 4 below rated high voltage.
 - 3. Taps, 750 kVA and Above: Four 2.5-percent taps, 2 above and 2 below rated high voltage.
- G. Wall-Mounting Brackets: Manufacturer's standard brackets for transformers up to 75 kVA.

2.4 FINISHES

- A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

- B. Outdoor Units: Comply with ANSI C57.12.28.

2.5 SOURCE QUALITY CONTROL

- A. Factory Tests: Design and routine tests comply with referenced standards.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project if specified sound levels are below standard ratings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with safety requirements of IEEE C2.
- B. Arrange equipment to provide adequate spacing for access and for circulation of cooling air.
- C. Identify transformers and install warning signs according to Division 16 Section "Electrical Identification."

3.2 GROUNDING

- A. Separately Derived Systems: Comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer.
- B. Comply with Division 16 Section "Grounding" for materials and installation requirements.

3.3 CLEANING

- A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.4 ADJUSTING

- A. After installing and cleaning, touch up scratches and mars on finish to match original finish.
- B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit with test results.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes load centers and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:
 - 1. Lighting and appliance branch-circuit panelboards.
 - 2. Distribution panelboards.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.
- F. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- C. Maintenance Data: For panelboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Contract Closeout," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NEMA PB 1.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Square D Co.

2.2 FABRICATION AND FEATURES

- A. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1, to meet environmental conditions at installed location.
- B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
- C. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
- D. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

- E. Bus: Hard-drawn copper, 98 percent conductivity
- F. Main and Neutral Lugs: Mechanical type suitable for use with conductor material.
- G. Equipment Ground Bus: Hard drawn copper adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
- H. Isolated Equipment Ground Bus: Hard drawn copper adequate for branch-circuit equipment ground conductors; insulated from box.
- I. Extra-Capacity Neutral Bus: Hard drawn copper neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
- J. Split Bus: Vertical buses divided into individual vertical sections.
- K. Gutter Barrier: Arrange to isolate individual panel sections.
- L. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Front mounted with concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 DISTRIBUTION PANELBOARDS

- A. Doors: Front mounted secured with vault-type latch with tumbler lock; keyed alike.
- B. Main Overcurrent Protective Devices: Circuit breaker, bolt on type.
- C. Branch overcurrent protective devices shall be one of the following:
 - 1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
 - 2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.6 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: Bolt on type NEMA AB 1, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I²t response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 5. GFCI Circuit Breakers: Single- and two-pole configurations with 5 mA trip sensitivity.
 - 6. All 120V, 15 and 20A circuits in dwelling units shall be on Arc Fault Circuit Interrupter type circuit breakers. All circuits shall have a dedicated neutral.
- B. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mounting Heights: Top of trim **74 inches** above finished floor, unless otherwise indicated.
- C. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- D. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- E. Install filler plates in unused spaces.
- F. Provision for Future Circuits at Flush Panelboards: Stub four **1-inch** empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in

the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

- G. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section
- B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.4 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes receptacles, connectors, switches, and finish plates.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.

1.4 SUBMITTALS

- A. Product Data: For each product specified.
- B. Maintenance Data: For materials and products to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- B. Comply with NEMA WD 1.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 RECEPTACLES

- A. Duplex receptacles shall be of the grounding type arranged for back and side wiring, with separate single or double grounding terminals. Receptacles shall be straight blade rated 20 amperes, 125 volt. The face configuration shall comply to the NEMA standard No. WDI.101968 and shall be approved third party listed. Self grounding or automatic type grounding receptacles are not acceptable in lieu of receptacle with separate hex head green grounding screw lugs and a direct green insulated conductor connection to the equipment grounding system.
- B. Receptacles shall be heavy duty specification grade mounted vertically. Receptacles mounted over counters, back splashes, etc. shall be mounted horizontally.
- C. GFCI Receptacles: Feed-through type, with integral NEMA WD 6, 20 ampere rated, Configuration 5-20R duplex receptacle arranged to protect connected downstream receptacles on same circuit.
- D. Industrial Heavy-Duty Receptacle: Comply with IEC 309-1.
- E. Hazardous (Classified) Location Receptacles: Comply with NEMA FB 11.

2.2 SWITCHES

- A. Snap Switches: Heavy-duty, quiet type, single pole, three way, or four way as indicated on the drawings. Switches shall be grounding type with hex head grounding screw rated 20 amperes, 120/277 volts A.C. only. All switches shall have quiet operating mechanism without the use of mercury. All switches shall be listed by an approved third party agency approved for the voltage and amperage indicated.
- B. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible and electromagnetic noise filters.
 - 1. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle, or slide; single pole with soft tap or other quiet switch; electromagnetic filter to eliminate noise, RF, and TV interference; and 5-inch wire connecting leads.
 - 2. Fluorescent Lamp Dimmers: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming to a maximum of 1 percent of full brightness.

2.3 WALL PLATES

- A. Single and combination types match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.04-inch- thick, Type 302, satin-finished stainless steel.
 - 3. Material for Unfinished Spaces: Galvanized steel.

2.4 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

- B. Compartmentation: Barrier separates power and signal compartments.
- C. Housing Material: Die-cast aluminum, satin finished.
- D. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Signal Outlet: Blank cover with bushed cable opening, unless otherwise indicated.

2.5 MULTIOUTLET ASSEMBLIES

- A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- B. Raceway Material: Metal, with manufacturer's standard finish.
- C. Raceway Material: Nonmetal.
- D. Wire: No. 12 AWG.

2.6 FINISHES

- A. Color: Ivory, unless otherwise indicated or required by Code.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies plumb and secure.
- B. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.
- C. Do not share neutral conductor on load side of dimmers.
- D. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Electrical Identification."
 - 1. Receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes.

3.3 CONNECTIONS

- A. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor. All circuits shall have a green grounding conductor.
- B. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.

3.4 FIELD QUALITY CONTROL

- A. Test wiring devices for proper polarity and ground continuity.
- B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- C. Replace damaged or defective components.

3.5 CLEANING

- A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

3.6 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."
 - 1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective

devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Enclosures.

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: For power, signal, and control wiring.
- C. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
- D. Field quality-control reports.
- E. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D Co.
 - 2. General Electric Co.; Electrical Distribution & Control Division.
 - 3. Cutler Hammer
 - 4. ITE

2.2 ENCLOSED CIRCUIT BREAKERS

- A. Enclosed, thermal magnetic circuit breakers.
- B. Enclosure and circuit breaker assembly shall be a Listed as suitable for use as service equipment. Assembly shall have a short circuit interruption capacity no less than the rating indicated on the plans.
- C. Provide with a permanently installed means to lock handle in the off position.
- D. Shall be used for main electrical service entrance disconnects.

2.3 ENCLOSED SWITCHES

- A. Enclosed, Nonfusible Switch: NEMA KS 1, Type Heavy Duty (HD) with lockable handle.
- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle with two padlocks, and interlocked with cover in closed position.
- C. Fusible safety switches with short circuit withstand ratings of 100K Amp or 200K Amp require Class R or Class J rejection fuse block feature. (Comply with NEC Article 110-9 and 240-60b)
- D. Select/Provide Fuses per the following criteria
 - 1. Service Entrance and Feeder Circuits over 600A: Class L, U/L listed, current limiting with 200K Amp interrupting capacity.
 - 2. Service Entrance and Feeder Circuits 600A and less: Class RK1 or J, U/L listed, current limiting with 200K Amp interrupting capacity.
 - 3. Motors, Motor Controller & Transformer Circuits: Class RK5, U/L listed, current limiting time delay with 200K Amp interrupting capacity
 - 4. Individual Equipment where fault current does not exceed 50 KA: Class K5, U/L listed, with 50KA interrupting capacity

- E. Spare Fuses: Provide 10% spare fuses of each size and type required with a minimum of one set of each.

2.4 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosures before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section.
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.
- B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

END OF SECTION 262816

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures, lamps, and ballasts.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.
 - 5. Retrofit kits for fluorescent lighting fixtures.
- B. See Division 26 Section "Network Lighting Controls" for manual or programmable control systems employing low-voltage control wiring or data communication circuits.
- C. See Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
- D. See Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.2 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
- C. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.
- D. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

- A. Metal Parts: Free from burrs, sharp corners, and edges.
- B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.
- D. Fluorescent Fixture General Requirements: Fixtures shall be provided with programmed start electronic ballasts and energy efficient T8 lamps unless noted otherwise on the drawings.
- E. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:
1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
 4. Laminated Silver Metallized Film: 90 percent.
- F. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.
1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
 2. Lens Thickness: 0.125 inch minimum, unless greater thickness is indicated.

2.3 FLUORESCENT LAMP BALLASTS

- A. General Requirements: Unless otherwise indicated, features include the following:
1. Electronic type designed for type and quantity of lamps indicated at full light output. Arrange ballast for dual switching of fixtures as indicated.
 2. UL listed type P, Sound Rating A, and meet or exceed ANSI C82.11 requirements.
 3. Programmed Start ballasts only.
 4. High Power Factor (90% minimum power factor)

5. Current crest factor equal to or less than 1.7
 6. Input current third harmonics shall not exceed ANSI recommendations (32% total harmonic distortion, 27.5% of the third triplets).
 7. Flicker less than 15%.
 8. Ballast design shall withstand line transients per IEEE 587 Category A and shall meet FCC rules and regulations Part 18
 9. Ballast case temperature shall not exceed 25°C rise over 40°C ambient.
 10. Parallel wiring between the ballast and fixture.
 11. Minimum of five (5) years warranty is required with each electronic ballast.
 12. Manufacturers shall have at least 5 years of experience in manufacturing electronic ballast.
- B. Electronic Ballasts for Linear Lamps: Unless otherwise indicated, features include the following, besides those in "General Requirements" Paragraph above:
1. Encapsulation: Without voids in potting compound.
 2. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.
- C. Ballasts for Compact Lamps in Recessed Fixtures: Unless otherwise indicated, additional features include the following:
1. Type: Electronic or electromagnetic, fully encapsulated in potting compound.
 2. Power Factor: 90 percent, minimum.
 3. Operating Frequency: 20 kHz or higher.
 4. Flicker: Less than 5 percent.
 5. Lamp Current Crest Factor: Less than 1.7.
 6. Transient Protection: Comply with IEEE C62.41 for Category A1 locations.
- D. Ballasts for Dimmer-Controlled Fixtures: Comply with general and fixture-related requirements above for electronic ballasts.
1. Compatibility: Certified by manufacturer for use with specific dimming system indicated for use with each dimming ballast.
- E. Ballasts for Low-Temperature Environments: As follows:
1. Temperatures -20 Deg F and Above: Electronic type rated for -20 deg F starting temperature.
- 2.4 EMERGENCY EXIT LUMINAIRE
- A. General Requirements: Comply with UL 924 and the following:
1. Emergency Exit fixtures shall be completely self-contained, provided with maintenance-free 12 volt battery, automatic charger, and other features. Luminaire shall be third-party listed as emergency lighting equipment, and meet or exceed the following standards: NEC, NC Building Code, Volume X Energy Code, NFPA-101, and NEMA standards.

2. Fixture shall have a three year warranty with an additional two more years prorated warranty for the battery. Warranty shall start from the date of project acceptance.
- B. Internally Lighted Signs: As follows:
 1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life. Maximum LED failure rate shall be 25% within a seven (7) year period; otherwise, if exceeded manufacturer shall replace the complete unit at no charge to the owner.
- C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 1. Battery: Sealed, maintenance-free, with a minimum of 90 minutes operating endurance and a normal life expectancy of 10 years. Battery shall be a high temperature type with an operating range of 0°C to 60°C and contain a resealable pressure vent, a sintered + positive terminal and – negative terminal.
 2. Charger: Fully automatic solid-state type, full wave rectifying, with current limiting. Charger shall restore the battery to its full charge within 24 hours after a discharge of 90 minutes under full load. The unit shall be activated when the voltage drops below 80 per cent. A low voltage disconnect switch shall be included if LEAD Battery is used to disconnect the battery from the load and prevent damage from a deep discharge during extended power outage.
 3. Operation: Relay automatically energizes lamp from unit when circuit voltage drops to 80 percent of nominal or below. When normal voltage is restored, relay disconnects lamps, and battery is automatically recharged and floated on charger.
 4. Provide a pilot light to indicate the unit is connected to AC power. The battery shall have high rate charge pilot unless self diagnostic type. A test switch shall be included to simulate the operation of the unit upon loss of AC power by energizing the lamps from the battery. The simulation must also exercise the transfer relay.
 5. Test each emergency lighting unit and exit sign after it is permanently installed and charged for a minimum of 24 hours. Battery shall be tested for 90 minutes. The battery test shall be done 10 days prior to final inspection by the State Construction Office. Any unit which fails the test must be repaired or replaced and tested again. Copy of the test report must be sent to the State Construction Office.

2.5 EMERGENCY EGRESS LUMINAIRE

- A. General Requirements: Comply with UL 924 and the following:
 1. Emergency Egress luminaires shall be completely self-contained, provided with maintenance-free 12 volt battery, automatic charger, two lamps, and other features. Luminaire shall be third-party listed as emergency lighting equipment, and meet or exceed the following standards: NEC, NC Building Code, Volume X Energy Code, NFPA-101, and NEMA standards.
 2. Fixture shall have a three year warranty with an additional two more years prorated warranty for the battery. Warranty shall start from the date of project acceptance.

3. Battery: Sealed, maintenance-free, with a minimum of 90 minutes operating endurance and a normal life expectancy of 10 years. Battery shall be a high temperature type with an operating range of 0°C to 60°C and contain a resealable pressure vent, a sintered + positive terminal and – negative terminal.
4. Charger: Fully automatic solid-state type, full wave rectifying, with current limiting. Charger shall restore the battery to its full charge within 24 hours after a discharge of 90 minutes under full load. The unit shall be activated when the voltage drops below 80 per cent. A low voltage disconnect switch shall be included if LEAD Battery is used to disconnect the battery from the load and prevent damage from a deep discharge during extended power outage.
5. Operation: Relay automatically energizes lamp from unit when circuit voltage drops to 80 percent of nominal or below. When normal voltage is restored, relay disconnects lamps, and battery is automatically recharged and floated on charger.
6. Provide a pilot light to indicate the unit is connected to AC power. The battery shall have high rate charge pilot unless self diagnostic type. A test switch shall be included to simulate the operation of the unit upon loss of AC power by energizing the lamps from the battery. The simulation must also exercise the transfer relay.
7. Test each emergency lighting unit and exit sign after it is permanently installed and charged for a minimum of 24 hours. Battery shall be tested for 90 minutes. The battery test shall be done 10 days prior to final inspection by the State Construction Office. Any unit which fails the test must be repaired or replaced and tested again. Copy of the test report must be sent to the State Construction Office.
8. Emergency battery ballasts integral to normal fluorescent lighting fixtures shall be high lumen output. Battery ballasts shall be wired with both switched and unswitched circuit legs in order to allow normal switching of emergency lamps.
9. Where installed outdoors shall be rated for low temperature applications (-20°F).

2.6 LAMPS

- A. Fluorescent Color Temperature and Minimum Color-Rendering Index: 3500 K and 85 CRI, unless otherwise indicated.
- B. Fluorescent lamps shall comply with the EPA Guidelines regarding the Toxicity Characteristic Leaching Procedure TCLP.
- C. Noncompact Fluorescent Lamp Life: Rated average is 20,000 hours at 3 hours per start when used on rapid-start circuits.
- D. Metal-Halide Color Temperature and Minimum Color-Rendering Index: 3600 K and 70 CRI, unless otherwise indicated.
- E. LED lamps: 3500 K and 85 CRI, unless otherwise indicated in plans. 50,000 hours minimum lamps life and 5 year minimum warranty.

2.7 FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Basic Electrical Materials and Methods," for channel- and angle-iron supports and nonmetallic channel and angle supports.

2.8 FINISHES

- A. Fixtures: Manufacturer's standard, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.
- B. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
 - 1. Where a recessed fluorescent, high intensity discharge, or downlight fixture displaces a section or part of ceiling tile fixture shall be supported at two diagonally opposite corners with the same type of wire used to support the lay-in ceiling track. Attach one end of the wire to the corner of the fixture and the other end to the building structure. The lay-in fixture shall then be screwed to the main runners of the lay-in ceiling track at all four corners using sheet metal screws. For fire rated suspended ceiling, luminaire shall be supported to the building structure per the ceiling design criteria, luminaire shall then be screwed to the main runners of the suspended ceiling at all four (4) corners using sheet metal screws.
 - 2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- C. Suspended Fixture Support: As follows:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

3.2 CONNECTIONS

- A. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Malfunctioning Fixtures and Components: Replace or repair, then retest.

3.4 CLEANING AND ADJUSTING

- A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.
- B. Adjust aimable fixtures to provide required light intensities.

END OF SECTION 265100

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes a turn-key upgrade of the existing Cerebus Pyrotronics MXL-IQ (by Siemens) addressable fire alarm system to a new voice notification, addressable fire alarm system. System upgrades shall include the furnishing, installation and connection of microprocessor controlled, intelligent reporting, addressable fire alarm equipment required to form a complete coordinated system ready for operation. The system shall include, but not be limited to, alarm initiating devices, notification appliances, control panels, auxiliary control devices, annunciators, power supplies, and wiring as shown on the drawings and as specified herein.
- B. The Contractor shall furnish all parts, materials, and labor customarily required or provided for a complete and operating system, in accordance with all requirements applicable, even if each needed item is not specifically shown or described in the project plans or specifications.
- C. The facility shall have a fully functional fire alarm system at all times. The existing system will remain in place and be cut over to the new system in phases to minimize lapses in building fire alarm coverage – initiating and notification. During any lapses in coverage, the contractor will be responsible for providing an approved third party fire watch for all areas of the building without coverage. The contractor's staff or building occupants shall not be used to provide a fire watch.
- D. To reduce cost and minimize downtime in fire alarm coverage during system upgrade, it is the intent to use existing conduit and wiring to existing devices being replaced. If a proposed system can not operate completely using the existing wiring, the contractor will need to replace the wiring as required. Each manufacturer shall inspect the existing wiring and verify compatibility with their system during bidding and factor all necessary wiring upgrades into their pricing.
- E. Either of the following methods to upgrade the system are acceptable:
 - 1. Provide a new Siemens fire alarm system that is backwards compatible with the existing devices, or
 - 2. Provide one of the alternate approved systems and temporarily set up the new FACP as a slave to the existing system. The intent is to maintain initiation and notification coverage and to provide only one DACT that functions for the entire facility. Loops to be cutover to new system in a scheduled and coordinated manner. The existing notification circuit

power supplies to be temporarily reworked as required to be compatible with new system as cutover takes place.

- F. New conduit, boxes and wiring shall be provided as required to feed all new devices. See fire alarm plans for existing devices being replaced and new devices being installed.
- G. The existing addressable circuit wiring is Class B. This circuit will be extended as required to loop back to the new FACP in order to provide a complete Class A circuit. Where "T" taps are used to feed existing devices, contractor shall rework that part of the circuit as required to provide Class A wiring. See drawings for known locations of "T" taps and provisions for unknown "T" taps.
- H. All notification circuits shall be reworked as required to provide a fully synchronized visual and audible voice (speaker) notification system. Fire Alarm contractor shall be responsible for determining the required speaker wattages to provide 15dB above ambient noise levels.
- I. Where work requiring cutting, patching or drilling of walls or ceilings in areas outside of the major renovation project boundaries, all furniture and equipment in shall be covered and protected during work. Work areas shall be cleared of all dust and debris resulting from construction immediately after work is complete.
- J. The fire alarm system shall comply with applicable provisions of the NC Building Code, NFPA 70 - National Electrical Code (NEC), NFPA 72 - National Fire Alarm Code.

1.2 DEFINITIONS

- A. Definitions in NFPA 72 apply to fire alarm terms used in this Section.
- B. Authority Having Jurisdiction (AHJ) Defined, Building Permits.
 - 1. For private sector or local government projects the AHJ is the local government entity that approves project plans, issues building permits, and inspects construction.

1.3 SYSTEM DESCRIPTION

- A. New addressable system with voice notification. All equipment supplied must be specifically listed for the purpose for which it is used, and installed in accordance with any instructions included in its listing
- B. General: The system is to be the addressable type, with a 24vdc nominal operating voltage. All equipment supplied must be specifically listed for its

intended use and shall be installed in accordance with any instructions included in its listing.

- C. Network operations shall be via communication links that connect all network nodes and include data transfer. All communications trunk wiring shall be electrically supervised.
- D. The following protection against voltage transients and surges must be provided by the fire alarm equipment supplier, and installed by the contractor:
 - a. On AC Input: A feed-through (not a shunt-type) branch circuit transient arrestor. Install suppressor in a listed enclosure near the electrical panelboard, and trim excess lead lengths. Wind small coil in the branch circuit conductor just downstream of the suppressor connection. Coil to be 5 to 10 turns, about 1" diameter, and securely tie-wrapped.
 - b. On DC Circuits Extending Outside Building: Adjacent to the FACU, and also near point of entry to outlying building, provide "pi"-type filter on each leg, consisting of a primary arrestor, series impedance, and a fast acting secondary arrestor that clamps at 30v-40v. Devices using only MOV active elements are not acceptable.

1.4 SUBMITTALS

- A. General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not comply fully with each and every requirement of the specifications, the submittal shall clearly indicate such deviations.
- B. Product Data: Submit Manufacturer's technical product data, including specifications and installation instructions, for each type of fire alarm system equipment. Submit technical product data on the fire alarm service equipment. Submittals shall provide mA draw for each device submitted and the listed minimum voltage required to operate. Panel submittal shall list voltage drop allowed for panel and for individual NAC circuits.
- C. Shop Drawings:
 - 1. Submit shop drawings showing equipment, device identification numbers and locations, and connecting wiring of entire fire alarm system. Include wiring and riser diagrams. Wiring diagrams shall be based on the project floor plans, with devices and proposed conduit routing shown. Provide distance and route for each NAC (Notification Appliance Circuit). Riser diagrams shall show consecutive connections for all devices with addresses and ratings. Utilize existing device addresses where applicable.
 - 2. The fire alarm contractor shall submit complete Shop Drawings to the engineer for review, prior to performing any work. These shall clearly demonstrate compliance with the engineer's plans and specifications, which have a System Response Matrix showing the fire alarm system's

- actions (outputs) required for each type of alarm, supervisory, and trouble signal. Any non-compliant features must be fully described.
3. Engineer's approval (with or without corrections) of contractor's Shop Drawings, samples, cut sheets, etc., is for general conformance with the contract documents and design concept. It shall not relieve the contractor of responsibility for full compliance with the project plans and specifications, EXCEPT for any specific non-compliant features for which the engineer gives written authorization.
 4. SCO approval of shop drawings is also required. The contractor shall submit shop drawings to the engineer for approval prior to sending to other agencies. After approval by engineer the contractor shall forward the plans to other agencies for review and approval. A copy of the engineer's approval letter shall be a part of the retransmitted document.
- D. Wiring Diagrams: Detail all wiring and differentiate between manufacturer-installed and field-installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified.
- E. Wire and Cabling: Submit wire and cable for signal circuits and notification circuits.
- F. Installation Instructions: Submit Manufacturer's detailed installation instruction for all duct mounted smoke detectors, flow switches, tamper switches, supervisory switches, and similar items which require mechanical installation.
- G. Battery Calculations:
1. Provide battery calculations used to size secondary power source(s). Calculations must be submitted prior to installation of equipment. System shall be supplied from the life safety branch of the emergency generator and shall be provided with 24 hours of battery backup.
 2. Identify NAC current draws and voltage drops for each circuit in the submittal package. In no case shall the calculated voltage at any notification appliance fall below the minimum listed operating voltage for the devices used.
 3. Identify wattage of each speaker tap.
 4. Include a copy of system battery sizing calculations with the shop drawing submittal to the engineer. Use manufacturer's battery discharge curve to determine expected battery voltage after 24 hours of providing standby power. Then use calculated Notification Appliance Circuit current draw in the alarm mode to determine expected voltage drop at EOL, based on conductor resistance per manufacturer's data sheet or NEC.
 5. The voltage drop at EOL must not exceed 14% of the expected battery voltage, after the required standby time plus alarm time. (Typically, for a 24 volt system, this limits the voltage drop from the battery to the EOL to 3

- volts). Determine "worst case" voltage at far end of each NAC, by subtracting its calculated V-drop from the expected battery voltage. The result must be no less than the minimum listed operating voltage for the alarm notification appliances used.
6. All of these calculations must be placed on a dedicated sheet of as-built drawings, for future reference by fire alarm service technicians. NAC voltage drop is to be verified during system tests.
- H. Device Address List: Coordinate with final system programming.
- I. Maintenance Data: Submit maintenance data and parts lists for each type of fire alarm equipment installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in maintenance manual.
- J. Maintenance Contract: Submit a quote for a maintenance contract to provide all maintenance, test, and repair described below and/or in accordance with NFPA-72, "Guide for Testing Protection Signaling Systems". Include also a quote of unscheduled maintenance/repair, including hourly rates for technicians trained on this equipment, and response travel costs. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty. Maintenance and testing shall be on a semiannual basis or as required by the local AHJ which ever is the most restrictive. A preventive maintenance schedule shall be provided by the Contractor that shall describe the protocol for preventive maintenance. The schedule shall include:
1. Semiannual systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, water flow switches and all accessories of the fire alarm system.
 2. Semiannual testing of each circuit in the fire alarm system.
 3. Semiannual testing of each smoke detector in accordance with the requirements of NFPA 72.
- K. Certifications:
1. Submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses, and telephone numbers in the certification.
 - a. Installer's training certificate as defined under Quality Assurance

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is an authorized representative of the FACU manufacturer for both installation and maintenance of units required for this Project.
- B. Manufacturer Qualifications: A firm experienced in manufacturing systems similar to those indicated for this Project and with a record of successful in-service performance.
- C. Source Limitations: Obtain fire alarm system components through one source from a single manufacturer.
- D. Compliance with Local Requirements: Comply with applicable building code, local ordinances and regulations, and requirements of authorities having jurisdiction.
- E. Comply with NFPA 72. The fire alarm system shall comply with applicable provisions of the 2012 NC Fire Prevention Code (available for sale at NCDol), National Fire Alarm Code (NFPA 72-2007) and NFPA101 Lifesafety Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: The following manufacturers / systems are acceptable for the fire alarm system upgrade.
 - 1. Siemens Fire Finder XLSV - (Preferred Brand Alternate)
 - 2. Notifier 3030
 - 3. Edwards EST3
 - 4. Simplex 4100ES

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. Control of System: By the FACP.

2.3 FIRE ALARM CONTROL PANEL (FACP)

- A. FACP - General: The FACP shall meet the following general requirements (unless otherwise required by the owner for certain systems):
 - 1. The system is to be the addressable type, with a 24vdc nominal operating voltage.

2. The system is to have multiple access levels so owner's authorized personnel can disable individual alarm inputs or normal system responses (outputs) for alarms, without changing the system's executive programming or affecting operation of the rest of the system. How to do this must be included in the training required to be given to the owner's designated personnel, and must also be part of the written documentation provided by the fire alarm equipment supplier.
 3. Signal Line Circuits: (SLC) also called addressable loop - Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto an NFPA Style 6 (Class A) Signaling Line Circuit (SLC) with no "T" taps.
 4. Initiation Device Circuits: Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D).
 5. Notification Appliance Circuits: Notification appliance circuits shall be wired Class B (NFPA 72 Style Y).
 6. Digitized electronic signals shall employ check digits or multiple polling. In general a single ground or open on any system signaling line circuit, initiating device circuit, or notification appliance circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
 7. Loss of Power: Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.
- B. System Response to an Alarm Condition: When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
1. The system alarm LED shall flash.
 2. A local piezo-electric signal in the control panel shall sound.
 3. The 80-character LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
 4. On systems equipped with a printer, printing and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
 5. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated. Exact programming shall be provided by the Contractor to meet the Owner's requirements.
 6. Activate all fire alarm Notification Appliances in the building, sounding and flashing in synchronization continuously until manually silenced, or until the initiating device and control unit have been reset to normal condition.

7. Activate digital alarm communicator.
 8. Deactivate door hold control relay such that all smoke doors are allowed to close.
 9. Deactivate control relays allowing HVAC units to run.
 10. Activate elevator recall sequence if smoke is detected in any elevator lobby or in the elevator equipment room.
- C. System Response to a Trouble Condition:
1. Systems AC power trouble signal shall not be sent unless maintained for 1 to 8 hours (or more) Provide additional relays as required for this purpose.
 2. Provide immediate transmission of all other supervising signals.
 3. Provide adjustable time delay for all other trouble signals prior to transmission.
- D. FACP - Minimum Requirements: The FACP shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, local and remote operator terminals, printers, annunciators, and other system controlled devices. The main FACP shall perform the following functions:
1. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
 2. Supervise all initiating, signaling, and notification circuits throughout the facility by way of connection to monitor and control modules.
 3. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.
 4. Visually and audibly annunciate any trouble, supervisory or alarm condition on operator's terminals, panel display, and annunciators.
- E. System Capacity and General Operation: The system shall have the following capacities and general operation modes:
1. The FACP shall provide, or be capable of expansion to 198 intelligent/addressable devices per SLC and 2048 annunciation points, minimum, per system. The number of SLCs provided shall be as indicated on the Drawings. Total points shall be as indicated on the drawings or otherwise specified.
 2. The FACP shall include a full featured operator interface control and annunciation panel that shall include a backlit, 80 character liquid crystal display, individual, color coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.

3. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.
- F. The FACP shall be able to provide the following features:
- Upload/Download to PC Computer
 - Charger Rate Control
 - Alarm Verification with Tally
 - Drift Compensation
 - Automatic Day/Night Sensitivity Adjust
 - Device Blink Control
 - Pre-alarm Control Panel Indication
 - Trouble Reminder
 - NFPA 72 Smoke Detector Sensitivity Test
 - System Status Reports
 - Periodic Detector Test
 - Alarm Verification, by device, with tally
 - Non-Alarm Module Reporting
 - Block Acknowledge
 - Smoke Detector Maintenance Alert
 - Control-By-Time
- G. The control panel shall be capable of printing historical data and device parameters and shall include all equipment necessary to produce printouts, including an external printer and shall be U.L. listed as meeting the NFPA sensitivity testing and maintenance requirements without the need for manually removing and testing each smoke detector. The control panel shall provide a display and a printed list of these sensitivity measurements as a permanent record of the required sensitivity testing. The system shall also annunciate a trouble condition when any smoke detector approaches 80% of its alarm threshold due to gradual contamination, with an annunciation of the location of the smoke detector requiring service. If any specialized equipment must be used to program any function of the smoke detector devices, then one must be furnished as part of the system.
- H. The system shall perform time based control functions including automatic changes of specified smoke detector sensitivity settings.
- I. The Fire Alarm System shall have multiple access levels which permit the Owner's authorized personnel to disable individual alarm inputs or normal system responses (outputs) for alarms without changing the system's executive programming or affecting operation of the rest of the system. This must include the ability to override selected alarm inputs or system responses to alarms without affecting the remaining portions of the system. The owner shall be taught how to make these changes in the training program provided.

- J. Central Processing Unit: The Central Processing Unit (CPU) shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the CPU.
1. The CPU shall contain and execute all control-by-event (including ANDing, ORing, NOTing, CROSSZONEing) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure. The CPU shall also provide a real-time clock for time annotation of all system displays. The Time-of-Day and date shall not be lost if system primary and secondary power supplies fail.
 2. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.
 3. The CPU and associated equipment are to be protected so that they will not be affected by voltage surges or line transients consistent with UL standard 864.
- K. Operators Control: Provide an operators interface which allows the following minimum functions. In addition, the operators interface shall support any other functions required for system control and/or operation:
1. Acknowledge (ACK/STEP) Switch
 2. Signal Silence Switch
 3. System Reset Switch
 4. System Test Switch
 5. Lamp Test Switch
- L. Display: The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.
1. The system display shall provide an 80-character back-lit alphanumeric Liquid Crystal Display (LCD).
 2. The Display shall also provide four Light-Emitting-Diodes (LEDs), that will indicate the status of the following system parameters: AC POWER, SYSTEM ALARM, SYSTEM TROUBLE, and SIGNAL SILENCE.
 3. The system display shall provide a touch key-pad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be accessible through the display interface assembly to prevent unauthorized system control or programming.

- M. Signaling Line Circuit (SLC) Interface Board: The FACP shall contain SLC interface boards as required to communicate with the SLC. Each SLC board shall monitor and control a minimum of 198 intelligent addressable devices. This includes 99 analog detectors (Ionization, Photoelectric, or Thermal) and 99 monitor or control modules.
1. Each SLC interface board shall contain its own microprocessor, and shall be capable of operating in a local mode (any SLC input activates all or specific SLC outputs) in the event of a failure in the main CPU of the control panel. The SLC interface board shall not require any jumper cuts or address switch settings to initialize SLC Loop operations. SLC interface boards shall provide power and communicate with all intelligent addressable detectors and modules connected to it's SLC Loop on a single pair of wires. This SLC Loop shall be capable of operation as NFPA Style 6.
 2. Each SLC interface board shall receive analog information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular detector. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.
- N. Printer: Provide a printer to provide hard-copy printout of all changes in status of the system. The printer shall time-stamp such printouts with the current time-of-day and date. The printer shall be standard carriage with 80-characters per line and shall use standard pin-feed paper. Thermal printers are not acceptable. The printer shall operate from a 120 VAC, 60 Hz power source. Provide table and stand for printer if it is to remain constantly connected to the fire alarm panel.
- O. Remote Transmissions: The FACP shall be interfaced to a Digital Alarm Communications Transmitter (DACT).
- P. Power Supply: The FACP power supply(ies) shall operate on 120 VAC, 60 Hz and shall have a continuous rating adequate to power all equipment and functions in full alarm continuously. All modules and drivers must be able to withstand prolonged short circuits in the field wiring, either line-to-line or line-to-ground, without damage. Further, the power supply shall be expandable for additional notification appliance power in 3.0 Ampere increments.
- Q. The power supply shall provide a battery charger using dual-rate charging techniques for fast battery recharge.
- R. Batteries: Shall be completely maintenance free, shall not require liquids, fluid level checks or refilling, and shall not be capable of producing spills and/or

leaks. Batteries shall be sealed gel-cell type with expected life of 10 years. Battery voltage shall be as required by the FACP and related equipment. Battery shall have sufficient capacity to power the fire alarm system for not less than 24 hours plus 5 minutes of alarm (maximum load) upon a normal AC power failure. NAC circuits shall not exceed 75% of maximum current load allowed.

- S. Enclosures: The FACP shall be housed in a 3rd party listed cabinet suitable for surface or semi-flush mounting. Cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be hinged on either the right or left side (field selectable).

2.4 INITIATING DEVICES

- A. Addressable Devices - General: All initiating devices shall be individually addressable. Addressable devices shall comply with the following requirements:
 - 1. All addressable spot type and duct smoke detectors shall be the analog type and the alarm system shall automatically compensate for detector sensitivity changes due to ambient conditions and dust build-up within detectors. This feature must be armed and sensitivities set prior to acceptance of the system.
 - 2. Address Setting: Addressable devices shall provide an address-setting means.
 - 3. Connections: Addressable devices shall be connected to a Signaling Line Circuit (SLC) with two (2) wires.
 - 4. Operational Indications: Addressable initiation devices shall provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions, indicating that the device is operational and in regular communication with the control panel. Both LEDs shall be placed into steady illumination by the FACP to indicate that an alarm condition has been detected. The flashing mode operation of the detector LEDs shall be optional through the system field program. An output connection shall also be provided in the device base to connect an external remote alarm LED.
 - 5. Intelligent Initiation Devices: All smoke detectors shall be the "intelligent" in that smoke detector sensitivity shall be set through the FACP and shall be adjustable in the field through the field programming of the system. Sensitivity shall be capable of being automatically adjusted by the FACP on a time-of-day basis. Using software in the FACP, detectors shall be capable of automatically compensating for dust accumulation and other slow environmental changes that may affect performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.

6. Spot-type detectors must be the plug-in type, with a separate base (not a mounting ring), to facilitate their replacement and maintenance. The base shall have integral terminal strips for circuit connections, rather than wire pigtails. Each detector or detector base shall incorporate an LED to indicate alarm.
 7. Device mounting Base: Unless otherwise specified all detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature.
 8. Test Means: The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel when in the "test" condition.
 9. Device Identification: Detectors shall store an internal identifying type code that the control panel shall use to identify the type of device. Device identifications shall be either ION, PHOTO, or THERMAL.
- B. Photoelectric Smoke Detectors: Photoelectric smoke detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
- C. Ionization Smoke Detector: Ionization smoke detectors shall use the dual-chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.
- D. Thermal Detectors: Thermal Detectors shall be intelligent addressable devices rated at 135°F. (58°C.) and shall have a rate-of-rise element rated at 15°F. (9.4°C.) per minute. It shall connect via two wires to the Fire Alarm Control Panel Signaling Line Circuit. Up to 99 intelligent heat detectors may connect to one SLC loop. Thermal detectors shall use an electronic sensor to measure thermal conditions caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements.
1. Non-Rate of Rise Detectors: Provide thermal detectors with non-rate of rise thermal elements. Non-rate of rise detectors are indicated by NRR adjacent to the thermal detector symbol.
 2. Specialized Element Temperature Ratings: Provide thermal detectors with specialized element temperature ratings. Specialized element temperatures are indicated by a temperature rating adjacent to the thermal detector symbol, e.g. 195°F.
- E. Duct Smoke Detector: In-Duct Smoke Detector Housings shall accommodate a velocity rated photoelectric detector. The device, independent of the type used, shall provide continuous analog monitoring and alarm verification from

the panel. When sufficient smoke is sensed, an alarm signal shall be initiated at the FACP.

1. Installation: Duct detectors and related items shall be furnished and connected by the Division 16 (Electrical) Contractor but installed by the Division 15 (Mechanical) Contractor.
 - a. All air duct/plenum detectors must have a Remote Alarm Indicator Lamp (RAIL) installed in the nearest corridor or public area and identified by an engraved label affixed to the wall or ceiling. Duct smoke detectors are permitted to be installed only inside an air duct. It is not appropriate to mount them in front of a return air opening. Duct detectors shall also be installed in a manner that provides suitable, convenient access for required periodic cleaning and calibration.
 - b. Each duct detector installation shall have a hinged or latched duct access panel, 12x12 inches minimum, for sampling tube inspection and cleaning. Indicate airflow direction on the duct, adjacent to the detector, using stencil or permanent decal.
 - c. Duct detector sampling tubes shall extend the full width of the duct and extend through the far side of the duct. Seal around the tube where it penetrates the duct wall, and plug the end with a rubber stopper. Tubes over 48 inches long must be provided with additional center support for stability.
 - d. Duct smoke detector mounting position and air sampling tube orientation, are critical for proper operation. The Manufacturer's detailed installation instructions must be followed. The contractor shall mark the direction of air flow on the duct at each duct detector location.
 - e. All duct smoke detectors shall be programmed for fire alarm (not for supervisory annunciation).
- F. Addressable Pull Stations - General: Addressable pull stations shall, on command from the Control Panel, send data to the panel representing the state of the manual switch. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
 1. All pull stations shall be dual-action, have a positive, visual indication of operation and utilize a key type reset.
 2. Construction: Pull stations shall be constructed of Lexan or other material suitable to the installation environment with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches or larger. Stations shall be suitable for surface mounting or semiflush mounting as shown on the plans. Unless otherwise indicated on the Drawings pull stations shall be mounted at 48" Above Finished Floor.
- G. Identification of individual detectors is required. Assign each a unique number as follows, in sequence starting at the FACP: (Addressable Loop # -- Device #).

Put on the as-built plans, and also permanently mount on each detector's base so that it's readable standing on the floor below without having to remove the smoke detector. Exception: For detectors with housings (i.e., air duct, projected beam, air sampling, flame), apply the identification to a suitable location on exterior of their housing. The identification sequence labeled on devices shall match exactly the sequence programmed into the system and displayed at the fire alarm panel displays.

2.5 NOTIFICATION APPLIANCES

- A. Alarm notification appliances, both audible and visible, shall comply with NFPA 72 requirements for intensity and placement. The standard audible evacuation signal shall be voice in accordance with NFPA 72. Strobe lights shall be selected and located per NFPA 72 and all those installed in a single space must be synchronized.
- B. Alarm notification appliance (NAC) circuits shall be NFPA 72 Style Y (Class B). The load connected to each circuit must not exceed 80% of rated module output and the coverage of each circuit shall not exceed 3 floors (to limit the effect of faults, and to facilitate trouble-shooting). The NAC voltage drop during alarm must not exceed 14% of the voltage measured across the batteries at that time. The contractor shall use power outage testing to verify that the NAC circuit was installed properly.
- C. Strobe Lights shall be located as shown on the Drawings. Strobe lights indicated for use exterior to the building shall be mounted at the indicated elevation and listed for use in wet locations. Strobe lights shall operate with synchronized flash output and have the following specifications:
 - 1. Voltage: Strobe lights shall operate on 24 VDC nominal.
 - 2. Maximum pulse duration: 2/10ths of one second.
 - 3. Mounting: Provide flush mounting devices suitable for mounting in a standard single gang device box unless otherwise indicated on the Drawings. Unless otherwise indicated on the Drawings, strobe lights shall be mounted at 7'-6" Above Finished Floor (AFF) or 6" Below Finished Ceiling (BFC), whichever is lower.
 - 4. Strobe intensity and flash rate: Must meet minimum requirements of UL 1971. Provide strobe lights with minimum intensity Candela (Cd) rating of 15/75 Cd, or greater if such is indicated adjacent to the device symbol on the Drawings.
- D. Audible/Visual Combination Devices shall be located as shown on the Drawings and shall comply with all applicable requirements for both Programmable Speakers and Strobe Lights. Unless otherwise indicated on the Drawings, combination A/V devices shall be mounted at 7'-6" Above Finished Floor (AFF) or 6" Below Finished Ceiling (BFC), whichever is lower.

2.6 MISCELLANEOUS SYSTEM ITEMS

- A. Addressable Dry Contact Monitor Module: Addressable Monitor Modules shall be provided to connect one supervised IDC zone (either Style D or Style B) of non-addressable Alarm Initiating Devices (any Normally Open [N.O.] dry contact device) to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. Monitor modules shall be installed as required by the system configuration. All required monitor modules may not be shown on the Drawings.
1. Indication of Operation: An LED shall be provided that shall flash under normal conditions, indicating that the Monitor Module is operational and in regular communication with the control panel.
 2. Mounting Requirements: Monitor Modules shall mount in a standard 4-inch square, 2-1/8" deep electrical boxes. Modules must be located in conditioned spaces unless they are tested, listed and marked for continuous duty across the range of temperatures and humidities expected at their installed location.
 3. Supervision: Unless specifically noted otherwise on the drawings provide one monitor module for each sprinkler switch.
- B. Two Wire Detector Monitor Module: Addressable Monitor Modules shall be provided to connect one supervised IDC zone, Class A or B (Style D or B operation) of non-addressable 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device) to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. Monitor modules shall be installed as required by the system configuration. All required monitor modules may not be shown on the Drawings. Modules must be located in conditioned spaces unless they are tested, listed and marked for continuous duty across the range of temperatures and humidities expected at their installed location.
1. Indication of Operation: Unless otherwise indicated on the Drawings an LED shall be provided that shall flash under normal conditions, indicating that the Monitor Module is operational and in regular communication with the control panel.
 2. Mounting Requirements: Monitor Modules shall mount in a standard 4-inch square, 2-1/8" deep electrical boxes.
- C. Addressable Control Module: Addressable Control Modules shall be provided to supervise and control the operation of one conventional Notification Appliance Circuit (NAC) of compatible, 24 VDC powered, polarized Audio/Visual (A/V) Notification Appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay. The control module shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. An LED shall be provided that shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel. Modules

must be located in conditioned spaces unless they are tested, listed and marked for continuous duty across the range of temperatures and humidities expected at their installed location.

1. Mounting Requirements: Control Modules shall mount in a standard 4-inch square, 2-1/8" deep electrical boxes.
2. Configuration: The control module NAC circuit may be wired for Style Y (Class B) with up to 1 Amp of inductive A/V signal, or 2 Amps of resistive A/V signal operation, or as a dry contact (Form C) relay. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
3. Power Source: Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, 3rd party listed remote power supply. A/V power sources and connections are not shown on the Drawings
4. Test Switch: A magnetic test switch shall be provided to test the module without opening or shorting its NAC wiring.

D. Isolator Module: Isolator Modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The Isolator Module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. Modules must be readily accessible (not above ceiling) and clearly labeled.

1. Operation: Isolator Modules shall operate such that if a wire-to-wire short occurs, the Isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the Isolator Module shall automatically reconnect the isolated section. The Isolator Module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an Isolator Module after its normal operation.
2. Mounting: The Isolator Module shall mount in standard 4-inch square, 2-1/8" deep electrical boxes. It shall provide a single LED that shall flash to indicate that the Isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.
3. Labeling: Each isolation module must be clearly labeled, readily accessible for convenient inspection (not above a lay-in ceiling), and shown on as-built system drawings.

E. Serially Connected LED Annunciator: Annunciator shall communicate with the fire alarm control panel via an EIA-485 communications loop (four-wire) and shall individually annunciate all zones in the system. System zones shall be as indicated on the Drawings. Up to 10 annunciators may be connected to the EIA-485 communications loop.

1. Annunciator Indicators: The annunciator shall provide a red Alarm LED per zone, and a yellow Trouble LED per zone. The annunciator shall also have an "ON-LINE" LED, local piezo sounder, local acknowledge/lamp test switch, and custom zone/function identification labels. Annunciator switches may be used for System control such as, Global Acknowledge, Global Signal Silence, and Global System Reset. All annunciator switches and indicators shall be software programmable.
 2. LCD Alphanumeric Display Annunciator: The Alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text. The LCD annunciator shall display all alarm and trouble conditions in the system.
 3. System Capacity: The system shall allow a minimum of four LCD annunciators. In addition to annunciation functions, each LCD annunciator shall be capable of the following software programmed system functions: Acknowledge, Signal Silence and Reset.
 4. Connections: The annunciator shall connect to a two-wire EIA-485 interface. The two-wire connection shall be capable operation at distances of 6,000 feet. Provide interface to fiber optic cable systems and/or repeater units where such are indicated on the Drawings.
- F. Remote Annunciator Indicator Lights (RAIL): RAILS shall be provided with a key type switch for testing of the annunciated device. In addition, RAILS shall have the following features:
1. Voltage: RAILS shall operate on 24 VDC nominal.
 2. Mounting: Provide flush mounting devices suitable for mounting in a standard single gang device box unless otherwise indicated on the Drawings. Unless otherwise indicated on the Drawings, RAILS shall be mounted as described for electronic sounders above.
- G. Door Hold-Open Magnets: Door hold open magnets shall be suitable for mounting in a single gang electrical device box. Door hold open magnets shall be furnished with keepers, door chains, and other accessories as required to properly hold open doors as indicated on the Drawings. Holding force of the magnet shall be appropriate for the door to be held open. Door hold open magnets shall operate in a fail safe manner, i.e., the door shall release in event of a failure of voltage to the device.
1. Power Source: Door hold open magnets shall be configured to operate from a nominal 24 VDC system as supplied by the FACP or other power supply listed for the purpose. All hold open magnet supply sources, whether a part of the FACP or whether derived from a separate power supply, shall be supervised. Door hold open magnet circuits which use step-down transformers, 120 VAC, or local relays are not permitted.
 2. Device box support: Door hold open magnet device boxes shall be securely attached to the building structure by means of wood blocking or other equally effective means. Boxes attached directly to only one metal

stud or boxes supported by means of expansion type fasteners are not acceptable.

- H. Battery Power Supply (BPS) &/or Supplementary Notification Appliance Circuit (SNAC): These types of panels shall be completely maintenance free, shall not require liquids, fluid level checks or refilling, and shall not be capable of producing spills and/or leaks. Batteries shall be sealed gel-cell type with expected life of 10 years. Battery voltage shall be as required by the FACP and related equipment. Battery shall have sufficient capacity to power the fire alarm system for not less than 24 hours plus 15 minutes of alarm upon a normal AC power failure. Battery cabinet shall be twice the size of the batteries it will contain. NAC circuits shall not exceed 75% of maximum current load allowed.
- I. Surge Protection: The following protection against voltage transients and surges must be provided by the fire alarm equipment supplier, and installed by the electrical contractor:
 - 1. On AC Input: A series type, feed through (not shunt-type) branch circuit transient suppressor such as the EFI E100HW120, Leviton 51020-OWM, Emerson/Northern Technologies TCS-HWR, Transtector ACP100BW series, or equivalent UL 1449 - 2nd Edition Listed device submitted to and approved by the electrical design engineer.
 - 2. On DC Circuits Extending Outside Building: Adjacent to the FACP, and also near point of entry to outlying building, provide "pi"-type filter on each leg, consisting of a primary arrestor, series impedance, and a fast acting secondary arrestor that clamps at 30v-40v. Some acceptable models: Innovative Technology D2S33-2ML, Simplex 2081-9027/-9028, Transtector TSP8601, Ditek DTKxLVL series, Citel America B280-24V, Leviton 3824-OWM, Northern Technologies DLP-42. Submit data on others to the engineer for approval. UL 497B listing is normally a prerequisite for their consideration. Devices using only MOV active elements are not acceptable.

2.7 REMOTE DEVICE LOCATION-INDICATING LIGHTS AND IDENTIFICATION PLATES

- A. Description: LED indicating light near each smoke detector that may not be readily visible. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located.

2.8 MAGNETIC DOOR HOLDERS

- A. Door holders shall be:
 - 1. Magnetic Lock (fail-safe) utilizing a 24vdc magnet and contact plate
 - 2. Electro-Mechanical Lock (fail-safe) with reverse bevel type dead bolt.

- B. These doors must immediately unlock upon any fire alarm signal, loss of building AC power, disablement of the fire alarm system (defined as loss of its 24vdc power), or upon manual operation of an unlock switch at a constantly attended location.
- C. Where installed on smoke or fire doors, power failure shall cause these mechanisms to default to the egress mode with normal mechanical latching.

2.9 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module listed for use in providing a multiplex system address for listed fire alarm-initiating devices with normally open contacts.

2.10 PRINTER

- A. Provide a 120vac printer that uses ordinary (non-thermal) paper. Install in location and as detailed shown on plans.

2.11 WIRE

- A. Non-Power-Limited Circuits: Stranded-copper conductors type THHN/THWN with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 14 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum.
- B. Power-Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.
- C. Addressable loop (signaling line) circuits shall be wired with type FPL/FPLR/FPLP fire alarm cable, AWG 18 minimum, low capacitance, twisted shielded copper pair.
- D. All cable shall be plenum rated.

2.12 CONDUIT

- A. All conduit and fittings shall be minimum 3/4 inch size, with compression type fittings having insulated throats.

PART 3 - EXECUTION

3.1 FIRE ALARM SYSTEM:

- A. The fire alarm system shall be new and furnished with a warranty (parts & labor) of at least one year from the date of final inspection and acceptance by the Owner. Equipment, initiating devices, and alarm appliances shall be arranged as described in the Drawings; annunciator zones shall be configured as described in the Drawings.
- B. All equipment supplied must be specifically listed for its intended use and shall be installed in accordance with any instructions included in its listing. The most common non-compliance with listings is exceeding environmental limits. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the Riser/Connection diagram for all specific system installation/termination/wiring data.
- C. All system components shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load. Adhesives are not permitted to mount fire alarm system components to building surfaces or structure.
- D. When programming the system, activate the automatic drift compensation feature for all spot-type smoke detectors. Systems with alarm verification are not to have this feature activated without written direction from the owner's representative or the AHJ. Alarm verification must not be used with multi-sensor/multi-criteria detectors under any circumstances, as inadequate system response may result.
 - 1. Most applications of analog addressable smoke detectors do not require alarm verification to reduce nuisance alarms, as they are better able to discriminate between fire and common non-fire ambient events. A short operational test with normal occupancy can determine if transient ambient events are a problem
- E. Set spot-type smoke detector sensitivities to normal/medium, unless directed otherwise by the design engineer/owner's rep.
 - 1. High sensitivity may be appropriate in relatively benign, clean environments such as art museums and libraries, to improve system response time without causing nuisance alarms
- F. Print a complete System Status and Programming Report, after the above steps have been done. This must include the program settings for each alarm initiating device and the current sensitivity of each analog addressable smoke detector.

3.2 FIRE ALARM CONTROL EQUIPMENT INSTALLATION

- A. The technician who makes final connections and programs the FACP is legally the "installer" even though most field connections to system devices and appliances are normally made by electrical contractor personnel. The responsibility for assuring a proper installation overall rests with this individual fire alarm system technician. In addition to doing the final hookups and activating the system, this individual is expected to check enough field connections to assure a proper job was done there. The absence of system "trouble" signals is not a sufficient measure of the field wiring, which could have "T" taps, the wrong type of wire, improper terminations, ground (drain wire) issues, etc.
- B. No splices shall be made in the fire alarm system other than at device terminal blocks, or on terminal blocks in cabinets. Wire nuts and crimp splices are not permitted per North Carolina SCO Fire Alarm Guidelines.
- C. The electrical contractor is not permitted to apply power to the FACP or any system power supplies, or to make any connections to them. However, the electrical contractor is responsible for installing and making field connections to initiating devices, notification appliances, control relays, and other components.
- D. The FACP must have an Alarm Silence switch, and be equipped with the Subsequent Alarm (alarm resound) feature. Any remote annunciators or graphic displays located away from the alarm area must also include an audible signal with alarm resound feature.
- E. Notification Appliance Circuit booster power supplies must be individually monitored by the FACP and protected by a smoke detector per NFPA 72. They shall not be located above a ceiling, or in non-conditioned space. A 24vdc power circuit serving addressable control relays must also be monitored for integrity.
- F. All junction boxes shall be painted red (or to match existing facility color code) prior to pulling the wire. Those installed in finished areas are permitted to be painted outside to match the finish color.
- G. Basic operating instructions shall be framed and permanently mounted at the FACP. (If the owner concurs, they may instead be affixed to the inside of the FACP 's door.) In addition, the NFPA 72 "Record of Completion" must either be kept at/in the FACP, or its location shall be permanently indicated there by engraved label.
- H. Provide an engraved label inside the FACP identifying its 120vac power source, as follows: Panelboard location, panelboard identification, and branch circuit number.

- I. Alarm notification appliances (audible and visible) are to comply with NFPA 72, the North Carolina Building Code, and North Carolina Accessibility Code criteria for intensity and placement. The standard audible evacuation signal is the ANSI S3.41 three-pulse temporal pattern except it shall not be used if the planned action during fire emergency is to relocate occupants or protect in place, instead of immediate evacuation (e.g., some health care facilities, prisons). All strobe lights installed in a single space must be synchronized. See additional alarm notification appliance requirements for special situations. Contact the AHJ for additional information or to seek approval of any alternative design.

3.3 ADDRESSABLE INTERFACE MODULES (Control and Monitor Modules)

- A. Addressable interface modules (used to monitor all contact type initiating devices) must be located in conditioned space, unless they are tested, listed, and marked for continuous duty across the range of temperatures and humidity expected at their installed location.
- B. One module can serve as many as 3 sprinkler system valve supervisory switches in a single space; otherwise provide one module per switch.
- C. One module may serve as many as 6 heat detectors, in a single space.
- D. Sprinkler system supervisory circuits for monitoring valve position, air pressure, water temperature, pump status, etc., must cause distinct audible and visible indications at the FACP. The audible supervisory signal shall either be a 4" diameter bell or a pulsing piezo-electric alarm. Provide the following engraved label adjacent to the bell/alarm: "SPRINKLER STATUS ABNORMAL". If only valve position is supervised, provide an engraved label reading: "SPRINKLER VALVE CLOSED"

3.4 SURGE PROTECTION

- A. For each AC power circuit that interfaces with fire alarm equipment install a series type, AC suppressor in a listed enclosure near the electrical panelboard, and trim excess lead lengths. Wind small coil in the branch circuit conductor just downstream of the suppressor connection. Coil to be 5 to 10 turns, about 1" diameter, and securely tie-wrapped. This series impedance will improve the effectiveness of the suppressor in clipping fast rise time voltage transients. Shunt type suppressors are not allowed.
- B. On DC Circuits Extending Outside Building: Near the point of entry to or exit from each building install the surge arrestor in a labeled enclosure.

3.5 RISER DESIGN

- A. The outgoing and return loops run in 2 separate vertical risers, to promote survivability during fire.
- B. A single loop is permitted to serve a maximum of 3 floors. However, if any loop serves more than 1 floor, include an isolation module at each terminal cabinet it uses.
- C. Provide isolation modules (or isolator bases) along each SLC (addressable loop) – beginning, middle, end and every 25 devices.
- D. Notification Appliance Circuits (NAC's) are permitted to be Class "B" and serve a maximum of 3 floors.

3.6 AC POWER

- A. Systems are to be provided with a separate and independent source of emergency power. Switching to emergency power during alarm shall not cause signal drop-out. Batteries must meet the appropriate NFPA capacity requirements, with a 25% safety factor. This requirement is in effect even if generator power is supplied to the Fire Alarm Control Panel.
- B. The branch circuit breaker(s) supplying the system must be physically protected by panelboard lock or handle lock and each must be identified with a 1/4" permanent red dot applied to handle or exposed body area.
- C. Provide an engraved label at each fire alarm system control unit, system sub-panel or data gathering panel, supplementary notification appliance (SNAC) panel, digital alarm communicator, etc., identifying its 120vac power source, as follows: Panelboard location, panelboard identification, and branch circuit number.
- D. The fire alarm system shall monitor 120vac power to shunt trip breakers used in conjunction with fire suppression systems. Examples include a shunt trip used for cooking appliance power shut-off when the kitchen hood fire suppression system shoots, or primary elevator power shut-down upon sprinkler flow in any elevator equipment space or shaft. Use an addressable monitor module to accomplish this supervisory function.

3.7 CONDUIT AND WIRING

- A. The exterior of all junction boxes containing fire alarm conductors shall be painted red; box interiors shall not be painted. Box covers for junction boxes containing fire alarm conductors shall be painted red on both sides. All

painting of junction boxes and junction box covers shall be accomplished prior to installation of the boxes to avoid possible problems with overspray.

- B. Provide metal backboxes or plastic skirts as manufactured by the fire alarm manufacturer for devices installed in a surface mounted application. Such boxes shall match device in size and color.
- C. Box covers shall be labeled to indicate the circuit(s) or function of the conductors contained therein. Labels shall be neatly applied black lettering on a clear background. Handwritten labels or labels made from embossed tape are not acceptable.

3.8 WIRING INSTALLATION

- A. Wiring Method: Conduit runs up 6" above ceiling and turns out to above nearest accessible corridor ceiling w/ 90 degree bend and bushing at end. Plenum rated cable neatly organized and supported by "J" hooks or other approved means is acceptable wiring method above accessible ceilings except where conduit is specified.
- B. All wiring on the exterior of the building, in covered exterior spaces, where exposed, or where subject to physical damage shall be in conduit.
- C. Conduit and wiring shall be concealed in all finished areas of the building.
- D. Minimum conduit size: 3/4".
- E. Signaling Line Circuits (SLC's, also called addressable loops) must be NFPA Style 6 (Class A) with no "T" taps. Each must have a minimum of 20% spare addresses, for future use.
- F. To minimize wiring fault impact, isolation modules shall be provided as follows. If ceiling height ≤ 10 feet, isolator base type initiating devices are permitted to be used:
 - 1. In or immediately adjacent to the FACP, at each end of the addressable loop. These two isolators must be in the same room as the FACP and within 15 feet.
 - 2. After each 20 initiating devices and control points on the addressable loop, or a lesser number where recommended by the manufacturer. (Check instructions.)
 - 3. For loops with less than 20 devices and control points, install an isolator at the approximate middle of the loop (in addition to those at the FACP).
 - 4. Near the point any addressable circuit extends outside the building, except for those attached to the building exterior walls and well sheltered by walkways.

5. For loops covering more than one floor, install isolator at terminal cabinet on each floor (with additional isolator[s] on any floor with over 20 addresses).
 6. Each isolation module must be clearly labeled, readily accessible for convenient inspection (not above a lay-in ceiling), and shown on as-built drawings
- G. All conduits that penetrate outside walls from air conditioned space must have internal sealing (duct-seal), to prevent condensation from infiltrating humid air.
- H. There shall be no splices in the system other than at device terminal blocks, or on terminal blocks in cabinets. "Wire nuts" and crimp splices will not be permitted. Permanent wire markers shall be used to identify all connections at the FACU and other control equipment, at power supplies, and in terminal cabinets.
- I. Addressable loop (signaling line) circuits shall be wired with type FPL/FPLR/FPLP fire alarm cable, AWG 18 minimum, low capacitance, twisted shielded copper pair. Cable shield drain wires are to be connected at each device on the loop to maintain continuity, taped to insulate from ground, and terminated at the FACU. Acceptable cables have capacitance of 30pf/ft. maximum between conductors. The cable jacket color shall be red, with red (+) and black (-) conductor insulation.
1. EXCEPTION #1: Unshielded cable, otherwise equal to the above, is permitted to be used if the manufacturer's installation manual requires, or states preference for, unshielded cable.
 2. EXCEPTION #2: In underground conduit, use Type TC or PLTC cable (PE insulated) to avoid problems from moisture.
- J. All conduit shall be concealed in finished spaces.
- K. All outlet, junction and pull boxes shall be concealed or flush mounted in finished spaces.
- L. All conduits that penetrate outside walls from air conditioned space must have internal sealing (duct-seal), to prevent condensation from infiltrating humid air.
- M. All wiring shall be color coded in accordance with the following scheme, which shall be maintained throughout the system, without color change in any wire run:
1. Initiating Circuits, General Red (+)/White (-)
 2. Initiating Circuits, Smoke Only Violet (+)/Gray (-)
 3. Signal Line Circuit cable Red jacket with Red(+)/Black(-)
 4. Alarm Indicating Appliance Circuits Blue (+)/Black (-)
 5. AHU Shutdown Circuits Yellow (+)/Brown (-)
 6. Door Control Circuits Orange

7. Elevator Capture Circuits Brown

- N. Except as required otherwise all circuits in the system shall be wired with AWG 14, minimum, stranded copper, THHN/THWN conductors, installed in conduit. Color code as shown below throughout the system, without color change in any wire run.
1. Alarm notification Appliance Circuits (speakers/strobes).....Blue (+)/Black (-)
 2. Separate 24vdc Operating Power (for equipment).....Yellow (+)/Brown (-)
 3. Door Control Circuits (magnet power, if from system).....Orange
 4. Circuits from Addressable Modules (ZAM's) to Monitored Devices (AWG 14/16)...Violet(+)/Grey (-)
- O. Detection or alarm circuits must not be included in raceways containing AC power or AC control wiring. Within the FACP, any 120 VAC control wiring or other circuits with an externally supplied AC/DC voltage above the nominal 24 VDC system power must be properly separated from other circuits and the enclosure must have an appropriate warning label to alert service personnel to the potential hazard.
- P. Style 6 Circuits Required: Systems with one or more addressable sub-panels that (1) have an integral addressable loop controller, or (2) monitor multiple non-addressable initiation zones, shall comply with the NFPA 72 requirements for Style 6 circuits.
- Q. Permanent wire markers shall be used to identify all splices and terminations for each circuit. For splices, use markers or other means to indicate which conductors leads to the FACP. All junction boxes and covers shall be painted red prior to pulling wire. Those boxes in finished areas are permitted to be painted to match the finish color.
- R. In multistory buildings, all circuits leaving the riser on each floor shall feed through a labeled terminal block in a hinged enclosure accessible from the floor. If building layout requires the terminal cabinet to be above a drop ceiling, its location must be clearly and permanently identified with a placard readable from floor. Terminal block screws shall have pressure wire connectors of the self-lifting or box lug type.
- S. All wiring shall be checked for grounds, opens, and shorts, prior to termination at panels and installation of detector heads. The minimum resistance to ground or between any two conductors shall be ten (10) megohms, as verified with a megger. Provide advance notice to the A/E of these tests.
- T. The system shall be electrically supervised for open or (+/-) ground fault conditions in SLC, alarm circuits, and control circuits. Removal of any detection device, alarm appliance, plug-in relay, system module, or standby battery

connection shall also result in a trouble signal. Fire alarm signal shall override trouble signals, but any pre-alarm trouble signal shall reappear when the panel is reset.

3.9 NOTIFICATION DEVICES

- A. Both audible and visible alarm signals shall be provided. Visible signals must be the strobe (flash discharge) type, with white or clear lens, and shall comply with current ADA requirements for intensity and placement.
- B. The coverage of each fire alarm zone as described in the Drawings shall be indicated on the FACP and any remote annunciator. This may be accomplished by engraved labels, framed directories, and/or graphic displays. Label tape or handwritten labels are not acceptable.
- C. Alarm notification appliance (NAC) circuits shall be NFPA 72 Style Y (Class B). The load connected to each circuit must not exceed 80% of rated module output and the coverage of each circuit shall not exceed 3 floors (to limit the effect of faults, and to facilitate trouble-shooting). The NAC voltage drop during alarm must not exceed 14% of the voltage measured across the batteries at that time. To achieve this, the design must consider wire size, length of circuit, device load, inherent voltage loss within the FACP 's power supply, etc. The contractor shall use power outage testing to verify that the NAC circuit was designed and installed properly.
- D. End of Line (EOL) resistors: On fire alarm notification circuits, end of line resistors shall be installed in accessible terminal cabinets or dedicated accessible boxes, to facilitate testing and maintenance. EOL resistors shall be located as follows:
 - 1. In a location that is accessible to fire alarm maintenance personnel.
 - 2. In an area where maintenance or testing at the EOL resister location will not be disruptive to the normal use of the facility.
 - 3. In an area that is not easily accessible to the normal building occupants (objective is to avoid accidental or malicious damage by building occupants).
 - 4. In an area that is no higher than 9 ft. or lower than 7 ft. from the floor level.
 - 5. Not located in a stairway or bathroom location.

3.10 DETECTORS

- A. Automatic fire/smoke detectors used shall be selected in accordance with Table I, "Applications Matrix for Selecting Detection Devices".

- B. Detectors used for elevator: Primary and/or alternate recall points are as indicated on the control Matrix. Elevator capture or control signals shall come from the FACP as relayed by control modules.
- C. The FACP and all other control equipment locations, including any transponders, sub-panels, and booster power supplies, must be protected by a spot type smoke detector located within 15 feet of the equipment (measured horizontally).
- D. When installed in a room, detectors shall be oriented so their alarm light is visible from the nearest door to the corridor, unless Remote Alarm Indicator Light (RAIL) equipped.
- E. Spot-type smoke detectors shall have a built-in locking device to secure the head to the base, for tamper resistance. For detectors mounted within 12 feet of the floor, activate this lock after the system has been inspected and given final acceptance.
- F. Unless suitably protected against dust, paint, etc., spot type smoke detectors shall not be installed until the final construction clean-up has been completed. In the event of contamination during construction, the detectors must be replaced.
 - 1. Covers supplied with smoke detector heads do not provide protection against heavy construction dust, spray painting, etc., and must not be used for that purpose. They are suitable only during final, minor cleanup or touchup operations.
- G. Identification of individual detectors is required. Assign each a unique number as follows, in sequence starting at the FACP: (Addressable Loop # -- Device #). Show on the as-built plans, and also permanently mount on each detector's base so that it's readable standing on the floor below without having to remove the smoke detector. Exception: For detectors with housings (i.e., air duct, projected beam, air sampling, flame), apply the identification to a suitable location on exterior of their housing. Device labels may not be affixed to the device. Identification labels must be printed labels with black lettering on a clear background. Handwritten labels or labels made from embossed tape are not acceptable.
- H. Set spot-type smoke detector sensitivity to normal/ medium, unless directed otherwise by the design engineer or owner's representative. Make additional changes as directed during testing and certification of the system.
- I. Unless suitably protected against dust, paint, etc., detectors shall not be installed until the final construction clean-up has been completed. Contaminated detectors must be REPLACED by the Contractor at no additional cost to the Owner.

- 3.11 PRINTER: Provide a 120vac printer that uses ordinary (non-thermal) paper. Install in location shown on plans.
- 3.12 AIR HANDLER UNIT (AHU) SHUTDOWN
- A. A supervised "AHU Shutdown Defeat" switch must be provided in/adjacent to the FACP or as a key-operated function in the Remote Annunciator (if provided). If the RA option is utilized, provide an informative engraved label at the FACP about this function. The switch must cause a system "trouble" indication when it's placed in the off-normal ("Shutdown Defeated") position.
 - 1. This is to provide the owner with a convenient means to temporarily resume HVAC operation in the event an unwanted alarm will not clear, prior to arrival of the fire alarm service technician.
 - B. If the system includes AHU shutdown, silencing the alarm (without resetting) must not reverse the shutdown. A supervised "AHU Shutdown Defeat" switch must be provided in the FACP. The switch must be labeled and its "Normal" position indicated. Provide supervised Hand-Off-Auto switch(es) at the FACP for any building smoke control equipment (pressurization or exhaust fans).
- 3.13 ANNUNCIATOR
- A. Each addressable fire alarm system must include an LCD-type "zone" annunciator at (or in) the FACP. As a minimum, this annunciator is to indicate the specific type of alarm or supervisory signal (smoke detector, waterflow, sprinkler valve closed, etc.), for groups of addressable devices.
- 3.14 ALARM VERIFICATION FOR SMOKE DETECTORS
- A. The fire alarm system shall be equipped with Alarm Verification.
 - B. System shall provide as a feature an alternate signal processing algorithm to verify the presence of smoke. The algorithm shall be selectable during system programming. The total effective delay created by the verification algorithm shall not exceed 60 seconds.
- 3.15 REMOTE ALARM TRANSMISSION REQUIREMENTS
- A. Each system with automatic fire detection, or which monitors a sprinkler system, shall be equipped with a 4-channel (minimum) Digital Alarm Communicator Transmitter (DACT) for transmission of fire alarm, supervisory, and trouble signals to a Central Station, Remote Supervising Station, or Proprietary Supervising Station. DACT shall be dual line type in accordance with NFPA 72.
 - B. The following signals shall be reported as applicable:

1. Fire Alarm
 2. Sprinkler Waterflow Alarm
 3. Fire Pump Running Alarm (if pump provided)
 4. Fire Pump Abnormal Status Supervisory Signal
 5. Sprinkler Valve Tamper (Closed) Supervisory Signal
 6. Sprinkler Low Temperature / Air Pressure Supervisory Signal
 7. Burglary / Intrusion / Duress / Other Security or Emergency Alarm
 8. Fire Alarm System AC Power Trouble (only if 120vac interrupted for 1 to 8 hours)
- C. The precedence of DACT signals transmitted to the Supervising Station shall be as follows:
1. Fire Alarm
 2. Security Alarm
 3. Supervisory Signal
 4. Trouble Signal*
- D. * Loss of AC power to FACP must not be transmitted until it has continued for 1 hour minimum. This avoids nuisance transmissions to the supervising station for brief power outages (switching transients, thunderstorms)
- E. "Trouble" signals shall not be sent unless maintained for 60 seconds or more to avoid nuisance transmissions due to alarm verification cycles.
- F. DACT shall be compatible with the owner's alarm receiving equipment. Contractor shall program the PROM, connect each DACT to the telephone line(s) provided, and verify proper signal receipt by the Supervising Station.
- 3.16 AUTOMATIC SMOKE DOOR AND AUTOMATIC LOCK REQUIREMENTS
- A. Wall-mounted magnetic door holders and separate heavy-duty closers shall be used, instead of combination door control units. The electromagnets shall be controlled by the building's smoke detection system FACP. Individual smoke detector auxiliary contacts shall not be used to release door holders.
- B. Automatic door locks controlled by the system must be either fail safe magnetic locks or fail-safe electro-mechanical with reverse bevel dead bolts.
- C. All lock protected doors must immediately unlock upon fire alarm, loss of AC power, disablement of the fire alarm system (defined as loss of 24 VDC power) or upon manual operation of an unlock switch at a constantly attended location.

3.17 SPRINKLER SYSTEM MONITORING

- A. The following sprinkler system alarm and supervisory functions shall be provided as a part of the fire alarm system:
 - 1. Waterflow alarm, by sprinkler zone (not to exceed one floor).
 - 2. Supervision of each control valve.
 - 3. Supervision of air pressure, if used (both high and low).
 - 4. Supervision of fire pump.
- B. Sprinkler supervisory monitoring of flow switches, tamper switches, and similar functions shall be accomplished with a separate system address for each activity monitored.

3.18 FIRE ALARM SYSTEM INSTALLATION AND CONFIGURATION

- A. Supervision required: The connection between individual addressable modules and their contact type initiating device(s) must be supervised.
- B. Graphic Chart must be mounted behind Plexiglass and secured to surface. Mounting shall be such that charts cannot be removed without a flat head screw driver.
- C. Floor Plans with Device Numbers: A copy of the floor plans shall be provided in the control panel. A separate sheet shall be provided for each floor. Plans shall be reduced in size from engineering plans in order to fit on 11 x 14 sheets. All device addresses shall be clearly labeled on plans. Indicate locations of all cabinets, modules and end of line resistors. Plans shall be bound in book form. Sheets shall be laminated. Provide legend for symbols. Provide holder for plan book in panel or in a locked box adjacent to panel keyed to match panel. Provide label for box and book.

3.19 FIRE AND LIFE SAFETY CRITERIA FOR DOORS CONTROLLED BY FIRE ALARM SYSTEM

- A. Any exit or exit access doors that are locked to delay egress, in accordance with the NC Building Code, by use of one of the following types of locking hardware:
 - 1. Magnetic Lock (fail-safe) utilizing a 24vdc magnet and contact plate
 - 2. Electro-Mechanical Lock (fail-safe) with reverse bevel type dead bolt

Shall immediately unlock upon any fire alarm signal, loss of building AC power, disablement of the fire alarm system (defined as loss of its 24vdc power).
- B. Smoke doors held open by 24vdc wall/floor-mounted magnets powered by the FACP shall be released upon alarm. The resulting current drain shall be included in the standby battery calculations or the system must be

programmed to drop the door hold-open magnet load 60 seconds after the loss of 120vac power.

3.20 SYSTEM DOCUMENTATION, TRAINING, AND MAINTENANCE

- A. Maintenance: The manufacturer, or authorized distributor, must maintain software version (VER) records on the system installed. The system software shall be upgraded free of any charge if a new VER is released during the warranty period. For new VER to correct operating problems, free upgrade shall apply during the entire life of the system.
- B. System Report In addition to the Shop Drawing submittal described elsewhere, the fire alarm system contractor shall provide the engineer two bound copies of the following technical information, for transmittal to the owner:
 - 1. As-Built wiring diagram showing all loop numbers and device addresses, plus terminal numbers where they connect to control equipment.
 - 2. Manufacturer's detailed maintenance requirements.
 - 3. Technical literature on all control equipment, isolation modules, power supplies, alarm/supervisory signal initiating devices, alarm notification appliances, relays, etc.
 - 4. The as-built "calculations" sheet
 - 5. Electronic archive: Complete configuration data (site-specific programming) for the system must be stored on electronic media and archived by the fire alarm system manufacturer or authorized distributor. A diskette or CD copy of this data shall be submitted to the engineer for transmission to the owner on the day the system is commissioned.
- C. The contractor shall provide the owner with three copies of the following:
 - 1. As-built wiring and conduit layout diagrams, including wire color code and/or label numbers, and showing all interconnections in the system.
 - 2. Electronic circuit diagrams of all control panels, modules, annunciators, communications panels, etc.
 - 3. Technical literature on all major parts of the system, including control panels, batteries, detectors, manual stations, alarm indicating appliances, power supplies, and remote alarm transmission means.
- D. The contractor shall provide the owner with one copy of the following:
 - 1. All software required, both for the installed fire alarm system and for any personal computer (PC) necessary to access the fire alarm system for trouble shooting, programming, modifications, monitoring, de-bugging, or similar functions.
 - 2. Complete documentation for all software for both the installed fire alarm system and for any interface PC software necessary for system functions as described in (i) above.

3. Framed floor plans, mounted at the FACP. Plans shall show all system devices with the unique device identification numbers indicated adjacent to each device. The identification numbers shall match those represented in the as-built drawings and those reported at the FACP and the LCD annunciator.
- E. The Contractor shall provide the owner with an interconnection cable where such is required to connect the fire alarm system to a PC.
- F. The manufacturer's authorized representative must instruct the owner's designated employees in operation of the system, and in all required periodic maintenance. A minimum of 8 hours on-site time shall be allocated for this purpose. Two copies of a written, bound summary shall be provided, for future reference.
 1. Scheduling of training shall be at the project site and coordinated with the Owner's schedule.
 2. Additional training shall be available at a cost to be mutually agreed upon by the Owner and the Contractor.
 3. Training shall cover the following topics at a minimum:
 - a. Preventive maintenance service techniques and schedules, including historical data trending of alarm and trouble records.
 - b. Overall system concepts, capabilities, and functions. Training shall be in depth, so that the owner shall be able to take any device out of service and return any device to service without need of Manufacture's approval or assistance.
 - c. Explanation of all control functions, including training to program and operate the system software.
 - d. Methods and means of troubleshooting and replacement of all field wiring devices.
 - e. Methods and procedures for troubleshooting the main fire alarm control panel, including field peripheral devices as to programming, bussing systems, internal panel and unit wiring, circuitry and interconnections.
 - f. Manuals, drawings, and technical documentation. Actual system software used for training shall be provided in digital form and shall be left with the Owner at the completion of training for the Owner's use in the future.

3.21 SPARE PARTS

- A. The following spare parts shall be provided with the system. For multi-building projects, calculate quantities separately for each building that contains a dedicated fire alarm control panel. If FACP also serves auxiliary buildings (e.g., storage, boiler/chiller), calculate as if one building. Increase decimal quantities to the next higher whole number
 1. Fuses (If Used).....2 of each size in system
 2. Manual Fire Alarm Boxes.....2% of installed quantity

3. Addressable Control Relays.....4% of installed quantity
4. Indoor Speakers with Strobes Lights.....4% of installed quantity
5. Indoor Strobe-only Notification Appliances.....4% of installed quantity
6. Monitor Modules (Addressable Interface).....4% of installed quantity
7. Isolation Modules / Isolation Bases.....4% of installed quantity
8. Addressable, Electronic Heat Detectors.....4% of installed quantity
9. Spot-Type Smoke Detectors.....6% of installed quantity
10. No spares are required for projected beam, air sampling, or duct smoke detectors

3.22 SYSTEM TESTING & CERTIFICATION

- A. Interim Testing: Each area shall be 100% tested as that loop is cut over from the old system to the new system. Verification of all other loops shall be made by testing 10% of devices. All interim testing shall be closely coordinated with the owner. Contractor shall provide fire watch for areas being cut over to new system until that portion of the system is fully tested and accepted.
- B. Upon completion of the installation the Division 16 Contractor and the Manufacturer's authorized installer together shall conduct a 100% performance test of each and every alarm initiating device for proper response. The system shall operate for 48 hours prior to start of test. The Division 16 Contractor shall be present for the full 100% test.
- C. 7 days advance notice required for witnessing of final tests.
- D. All Audio Visual Device Testing shall be scheduled with the owner.
- E. 100% Test: The manufacturer or authorized distributor (by definition, "installer") must 100% test all site-specific software functions for the system and then provide a detailed report or check list showing the system's operational matrix. This documentation must be part of the "System Status and Programming Report".
 1. Upon completion of the installation and its programming, the installer's technician shall test every alarm initiating device for proper response and indication, and all alarm notification appliances for effectiveness. Also, in coordination with the other building system contractors, all other system functions shall be verified, including (where applicable) elevator capture and the control of HVAC systems, door locks, pressurization fans, fire or smoke doors/dampers/shutters, etc. The engineer must be notified in advance of these 100% tests, to permit witnessing them if desired.
 2. If AHU shutdown occurs for any alarm, then the matrix would indicate the specific control relay(s) for that function being commanded to operate for alarm from any initiating device.
 3. The digital communicator shall be on-line and tested for proper communication to the receiving station.

4. All supervised circuits shall be tested to verify proper supervision. (Control circuits and remote annunciation lines are among those required to be supervised.)
 5. All testing described above shall be repeated in the event that subsequent software or wiring modifications are determined necessary to meet the requirements of the contract documents. Such re-testing shall be included as part of the base bid and provided at no additional cost to the Owner.
- F. Test Documentation: The installer shall fill out and submit the following documentation to the owner, through the engineer, prior to the AHJ's system acceptance inspection:
1. Written verification that this 100% system test was done with copy of print out generated during test.
 2. The NFPA 72, "Record of Completion" Form. Use this form (no substitutes) to detail the system installation and also to certify that: (a.) It was done per Code, and (b.) The Code-required 100% test was performed. The fire alarm installer (manufacturer or authorized distributor's technician) shall sign this form. If a representative of the AHJ, owner, or engineer witnesses the tests, in whole or in part, they shall also sign the form to signify that fact only (annotating the form as needed to clarify their limited role).
 3. The System Status and Programming Report described in NFPA 72. This shall be generated on the day of the system acceptance inspection and shall include the measured sensitivity of each smoke detector.
 4. After completion of the 100% system test and submission of documentation as described above the installer is to request the engineer to set up an inspection. The system shall operate for at least two days prior to this inspection.
 5. The responding Fire Department shall be notified of this, for pre-fire planning purposes. On local government projects, local fire authorities may also want to participate in system acceptance inspections.
- 3.23 PRE -FINAL INSPECTION
- A. After passing the Designer's pre-final inspection, the Contractor and Manufacturer's authorized installer will conduct system test in the presence of the Owner and the Designer.
- 3.24 FINAL INSPECTION
- A. The fire alarm system will be inspected, with portions of it functionally tested. This will normally include the use of appropriate means to simulate smoke for testing detectors, as well as functionally testing the system interface with building controls, fire extinguishing systems and any off-premises supervising station. This

statistical (sampling) inspection is intended to assure that the contractor has properly installed the system and performed the 100% operational test as required by NFPA 72. The electrical contractor shall provide two-way radios, ladders, and any other materials needed for testing the system, including a suitable smoke source.

1. The test will be conducted entirely by the Contractor. A copy of the final database software must be presented to the Owner before this test. The software shall be loaded from these disks into the system in the presence of the Owner. The review will then be conducted using this software. Any deficiencies shall be recorded and corrected. After the items have been corrected, the system shall be tested again.
- B. In the event of malfunctions or excessive nuisance alarms, the Contractor must take prompt corrective action. The Owner may require a repeat of the Contractor's 100% system test, or other inspections.
- C. Test Report: Upon successful completion of the Inspection and after the correction of all deficiencies, the manufacturer's authorized representative shall issue a test report to the Engineer and Owner, detailing and certifying the test.
- D. System Acceptance: After successful completion of the Final Inspection and recommendation of the Engineer, the system will be accepted by the Owner. At this time the warranty period begins.

3.25 GROUNDING

- A. Ground cable shields and equipment according to system manufacturer's written instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

3.26 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean equipment internally using methods and materials recommended by manufacturer.

3.27 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to three requested visits to Project site for this purpose.

END OF SECTION 283111

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Protecting and removing existing trees, shrubs, groundcovers, plants and grass as required on the drawings.
 - 2. Clearing and grubbing.
 - 3. Stripping and stockpiling topsoil.
 - 4. Removing above- and below-grade site improvements.
 - 5. Disconnecting and capping or sealing site utilities.
 - 6. Temporary erosion and sedimentation control measures.

1.2 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.3 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by City.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving."
 - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to sediment and erosion control Drawings.
- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
- B. Do not excavate within tree protection zones, unless otherwise indicated.

- C. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.

3.4 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
 - 1. Arrange with utility companies to shut off indicated utilities.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.

3.5 CLEARING AND GRUBBING

- A. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

3.8 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
 - 1. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 311000

SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and grasses, and exterior plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase and base course for asphalt paving.
6. Excavating and backfilling for utility trenches.

1.2 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

- G. Fill: Soil materials used to raise existing grades.
 - H. Undercut Excavation: Shall consist of the removal and disposal of unsuitable materials below the subgrade for footings and pavement sections and the replacement and compaction of suitable materials.
 - I. Open rock excavations: Includes removal and disposal of materials and obstructions encountered that cannot be effectively loosened or broken down by ripping in a single pass with a late model tractor-mounted hydraulic ripper equipped with one digging point of a standard manufacturer's design and adequately sized for use with and propelled by a D-8 CAT (min), having a draw bar pull of 65,000 lbs at 1MPH
 - 1. Typical of materials classified as rock are boulders 1.0 cu. yd. or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits.
 - 2. Intermittent drilling, or ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.
 - J. Trench rock excavation: Includes removal and disposal of materials and obstructions encountered that cannot be effectively loosened or broken by a CAT 330 (min) equipped with a 1.0 cu. yd. Rock bucket with a minimum breakout force of 37,900 pounds at a rate of 10 cu. Yd. Per hour.. Boulders larger than 0.75 cu. yd. in trenches are considered rock. Trenches in excess of 10 feet in width and pits in excess of 30 feet in either length or width are classified as open rock excavation.
 - K. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
 - L. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
 - M. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
 - N. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
- 1.3 PROJECT CONDITIONS
- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
 - B. The site has not been graded or designed to allow the site earthwork to balance. No warranty or guarantee is made that the site earthwork will balance. Borrow material may be required to be brought to the site to achieve the proposed grades. Excess material may be required to be removed from the site to achieve the proposed

grades. No warranty or guarantee is made that the existing soil proposed to be excavated from the site will be suitable for reuse on the site. The Contractor shall, at no additional cost to the Owner, import or export material from the site to reach the proposed grades. If materials excavated from the site above grade are unsuitable for reuse on the site, the Contractor will, at no additional cost to the Owner, remove them from the site and replace them with borrow material as required. The Owner will only provide additional compensation for unsuitable materials below the proposed subgrade. The top soil will be stripped and an amount as necessary for landscape and grass areas will be stockpiled for later use.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Non-highly plastic soil with a plasticity indices of 25 or less; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Highly plastic soil with a plasticity indices greater than 25, or soils not considered satisfactory.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 3 percent of optimum moisture content at time of compaction.
- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.2 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."
- C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing." during earthwork operations.

3.2 EXCAVATION

- A. Excavation Classifications: All excavation is classified as General Excavation except for Mass Rock, Trench Rock, and Unsuitable Soil Materials.
 - 1. General Excavation: Excavation, removal and/or disposal of pavements and other obstructions visible on surface; underground structures utilities and other items indicated to be demolished and/or removed; together with soil, boulders and other materials encountered that are not classified as rock, unsuitable soil, or unauthorized excavation.
 - a. Intermittence drilling and blasting to increase production and not necessary to permit excavation of material encountered will be considered general excavation.
 - b. Soil (irregardless of nature) or other debris encountered above proposed subgrade elevations shall be considered general excavation unless determined by the Engineer to meet the definition of rock.
 - 2. Unsuitable Soil Excavation: Removal and disposal of soil materials or other debris encountered at or below proposed subgrade elevations which is deemed to unsuitable to remain in place by the Engineer or Owner's Independent Testing Agency.

- a. Soil and/or other debris encountered above proposed subgrade elevations shall be considered general excavation.
 - b. Soil material which, in the opinion of the Engineer, can be repaired by scarifying, drying, and recompact or material which is made unsuitable by delay of work, lack of protection, or other actions of the Contractor or his Sub-contractors shall not be considered as unsuitable soil and shall be repaired or replaced by the Contractor at no additional cost to the Owner.
 - c. Any material moved or removed without measurement and approval by the Engineer or Owner will be considered as general excavation.
3. Classified excavation requirements:
- a. Excavations more than 10 feet in width and pits more than 30 feet in either length or width are defined as open excavations.
 - b. Contractor shall expose and clean the rock material for inspection and measurement.
 - c. Do not excavate rock or unsuitable material until it have been classified and cross-sectioned by the Engineer or Owner. Any material moved or removed without the measurement and approval by the Architect will be considered as unclassified excavation.
 - d. The Engineer will be the final judge as to what is classified as unsuitable or rock excavation.
 - e. The Contractor will provide equipment specification data verifying that the minimum rated equipment will be used for demonstration purposes. The equipment will be in good shape and in proper working condition.
 - f. Rippable rock, weathered rock, or overburden which is not classified as rock according to the definitions in this section shall be considered unclassified excavation.

3.3 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
- 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
 - 1. Clearance: 12 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 - 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material.

3.6 SUBGRADE INSPECTION

- A. Proof-roll subgrade below the building slabs, pavements, and areas to receive fill with a fully loaded tandem axel dump truck to identify soft pockets and areas of excess yielding in the presence of the Engineer or independent testing agency. Do not proof-roll wet or saturated subgrades.
- B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.7 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
 - 1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

3.8 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.9 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section ".
- D. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.
 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- E. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- F. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 1. Under grass and planted areas, use satisfactory soil material.
 2. Under walks and pavements, use satisfactory soil material.
 3. Under steps and ramps, use satisfactory soil material.
 4. Under building slabs, use satisfactory soil material.
 5. Under footings and foundations, use engineered fill.

3.11 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 3 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 3 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Moisture content during fill placement shall be kept within 3% of the optimum moisture.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D-698 (Standard Proctor):
 1. Under structures, building slab steps, and pavements scarify and recompact top 12 inches of existing subgrade and final 12" of backfill or fill soil material at 100 percent.
 2. Under walkways, scarify and recompact top 6 inches below existing subgrade and compact final 6" of backfill or fill soil material at 100 percent.
 3. Compact all other fill at 95%.

3.13 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 1. Lawn or Unpaved Areas: Plus or minus 1 inch.
 2. Walks: Plus or minus 1/2 inch.
 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.14 SUBBASE AND BASE COURSES

- A. Place subbase and/or base course on subgrades free of mud, frost, snow, or ice.

- B. On prepared subgrade, place subbase and base course under pavements and walks as follows:
 - 1. Proof roll prepared subgrade surface with a fully loaded tandem axel dump truck to identify soft pockets and areas of excess yielding in the presence of the Engineer or independent testing agency. Areas will be undercut and repaired as directed by the Engineer.
 - 2. Shape subbase and base course to required crown elevations and cross-slope grades.
 - 3. Compact subbase at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698 and the final 12" below subgrade to 100%.
 - 4. Compact base course and gravel pavement at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 100 percent of maximum dry unit weight as determined by AASHTO method T-180 as modified by NCDOT.
 - 5. When thickness of compacted base course is 6 inches or less, place material in a single layer.
 - 6. When thickness of compacted base course is 6 inches or more, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.
 - 7. Following compaction testing and within 48 hours prior to the application of asphalt or concrete pavement, the base course will be proof rolled with a fully loaded dual wheel tandem axel dump truck or similar construction equipment. The proof roll shall be observed by the Owner or his representative. Should any areas fail the proof roll, the base course will be scarified, moistened or aerated, recompacted, and repeat proof roll test.

3.15 DRAINAGE COURSE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
 - 1. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 - 2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 1556.

3.16 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- D. Testing agency will test compaction of soils in place according to ASTM D-608, ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.17 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property, at no additional cost to the Owner.

END OF SECTION 312000

SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold milling of existing hot-mix asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt paving overlay.
5. Pavement-marking paint.

B. Related Sections:

1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
2. Job-Mix Designs: For each job mix proposed for the Work.

B. Material Certificates: For each paving material, from manufacturer.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturers shall be registered with and approved by the North Carolina Department of Transportation

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the North Carolina Department of Transportation for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

C. Preinstallation Conference: Conduct conference at Project site.

1.4 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
 - 1. Tack Coat: Minimum surface temperature of 60 deg F
 - 2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials or 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
- B. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
- C. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a.
- B. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
- B. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking Paint.

1. Color: As indicated.
- C. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.
 1. Color: As indicated.
- D. Glass Beads: AASHTO M 247, Type 1.
- E. Thermoplastic Pavement Markings: Meet the requirements of the NCDOT Standard Specifications for Roads and Structures.
- F. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength,. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
 1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.

2.4 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 2. Intermediate Course: I-19.0B.
 3. Surface Course: SF9.5B

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 2 inches.

3.3 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.
 1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.
- C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.
 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- D. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.4 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 1. Spread mix at minimum temperature of 250 deg F.
 - 2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat to joints.
 - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
 - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.7 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 ASPHALT CURBS

- A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 deg F.
 - 1. Asphalt Mix: Same as pavement surface-course mix.
- B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.9 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
 - 3. Intermediate Course: Plus or minus 1/4 inch.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.

2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.10 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow paving to age for 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
- E. All pavement markings in the street right of way or at intersections with the street right of way will be made with thermoplastic markings according to the NCDOT Standard Specifications for Roads and Structures.

3.11 WHEEL STOPS

- A. Install wheel stops in bed of adhesive as recommended by manufacturer.
- B. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Replace and compact hot-mix asphalt where core tests were taken.
- C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.13 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 321216

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes exterior cement concrete pavement for the following:
 - 1. Driveways and roadways.
 - 2. Parking lots.
 - 3. Curbs and gutters.
 - 4. Walkways.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete pavement mixture.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.
- C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- D. Plain Steel Wire: ASTM A 82, as drawn.
- E. Deformed-Steel Wire: ASTM A 496.

- F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice."

2.2 CONCRETE MATERIALS

- A. Cementitious Material: Use one of the following cementitious materials, of the same type, brand, and source throughout the Project:
 - 1. Portland Cement: ASTM C 150, Type I or II.
 - a. Fly Ash: ASTM C 618.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C 33 coarse aggregate, uniformly graded. Provide aggregates from a single source.
- C. Water: ASTM C 94/C 94M.
- D. Air-Entraining Admixture: ASTM C 260.
- E. Chemical Admixtures: ASTM C 494/C 494M, of type suitable for application, certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

2.3 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
- E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- F. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B.

2.4 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- C. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, with drying time of less than 3 minutes.
 - 1. Color: As indicated.

2.5 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:
 - 1. Compressive Strength (28 Days): 4000 psi.
 - 2. Slump Limit: 4 inches, plus or minus 1 inch.
 - 3. Air Content: 5-1/2 to 4-1/2 percent plus or minus 1.5 percent.
- B. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions.

2.6 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness. Space contraction joints at a maximum of 10' on center unless otherwise specified.
- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.
- F. Locate expansion joints at 40' on center, unless otherwise indicated on the plans. Extend joint fillers full width and depth of joint, not less than 1/2" or more than 1" below finished surface where joint sealers are indicated. If no joint sealer is called for, place top of joint filler flush with concrete surface

3.5 CONCRETE PLACEMENT

- A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.
- B. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- D. Screed pavement surfaces with a straightedge and strike off.

- E. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.6 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
- C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on pavement surface according to manufacturer's written instructions.
 - 1. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
 - 2. After curing, lightly work surface with a steel wire brush or abrasive stone and water to expose nonslip aggregate.

3.7 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with the following materials:
 - a. Water
 - b. Continuous water-fog spray
 - c. Absorptive cover, water saturated, and kept continuously wet.

2. Moisture Retaining Cover Curing: Cover concrete surfaces with moisture retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period

3.8 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
 1. Elevation: 1/4 inch.
 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 3. Surface: Gap below 10-foot long, unleveled straightedge not to exceed 1/4 inch.
 4. Joint Spacing: 3 inches.
 5. Contraction Joint Depth: Plus 1/2 inch, no minus.
 6. Joint Width: Plus 1/8 inch, no minus.

3.9 PAVEMENT MARKING

- A. Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.
- B. Sweep and clean surface to eliminate loose material and dust.
- C. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.10 WHEEL STOPS

- A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded in holes drilled or cast into wheel stops at one-quarter to one-third points. Firmly bond each dowel to wheel stop and to pavement. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

- B. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement.
- C. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 32 13 73 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Expansion and contraction joints within cement concrete pavement.
 - 2. Joints between cement concrete and asphalt pavement.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For each type and color of joint sealant required.
- C. Product certificates.
- D. Compatibility and Adhesion Test Reports: From sealant manufacturer.

1.3 QUALITY ASSURANCE

- A. Preconstruction Compatibility and Adhesion Testing: Submit samples of materials that will contact or affect joint sealants to joint-sealant manufacturers for testing according to ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.
- B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.
 - 1. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 COLD-APPLIED JOINT SEALANTS

- A. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.
- B. Type SL Silicone Sealant for Concrete and Asphalt: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.

2.4 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.
- D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience.
- C. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- D. Install backer materials to support sealants during application and at position required to produce optimum sealant movement capability. Do not leave gaps between ends of backer materials. Do not stretch, twist, puncture, or tear backer materials. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- E. Install sealants at the same time backings are installed to completely fill recesses provided for each joint configuration and to produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
- G. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

END OF SECTION 321373

SECTION 32 14 00 - UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Brick pavers set in aggregate and mortar setting beds.
 - 2. Concrete pavers set in mortar setting beds.
 - 3. Steel edge restraints.

1.2 SUBMITTALS

- A. Product Data: For materials other than water and aggregates.
- B. Samples for unit pavers and edge restraints.

1.3 QUALITY ASSURANCE

- A. Mockups: Build mockups for each form and pattern of unit paver.
 - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 PROJECT CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or build on frozen subgrade or setting beds.
- B. Weather Limitations for Bituminous Setting Bed: Install bituminous setting bed only when ambient temperature is above 40 deg F and when base is dry.
- C. Cold-Weather Requirements for Mortar and Grout: Heat materials to provide mortar and grout temperatures between 40 and 120 deg F. Protect unit paver work against freezing for 24 hours after installation.

PART 2 - PRODUCTS

2.1 BRICK PAVERS

- A. Brick Pavers: Light-traffic paving brick; ASTM C 902, Class SX, Type I, Application PA. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.
1. Basis-of-Design Product: The design for brick pavers is based on Pine Rumbled Pavers Full Range. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
 - a. Pine Hall Brick Company, Inc.
 2. Thickness: 2-1/4 inches (57 mm)
 3. Face Size: 4 by 8 inches (102 by 203mm)
 4. Color: Full-range. As selected by architect to match existing pavers adjacent to project site.
- B. Brick Pavers: Heavy vehicular paving brick; ASTM C 1272, Type R, Application PA. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.
1. Basis-of-Design Product: The design for brick pavers is based on Pine Rumbled Pavers Full Range. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
 - a. Pine Hall Brick Company, Inc.
 2. Thickness: 2-1/4 inches (57 mm)
 3. Face Size: 4 by 8 inches (102 by 203mm)
 4. Color: Full-range. As selected by architect to match existing pavers adjacent to project site.
- C. Temporary Protective Coating: Precoat exposed surfaces of brick pavers with a temporary protective coating that is compatible with brick, mortar, and grout products. Do not coat unexposed brick surfaces.
- D. Efflorescence: Brick shall be rated "not effloresced" when tested according to ASTM C 67

2.2 ACCESSORIES

- A. Steel Edge Restraints: Painted steel edging 3/16 inch thick by 4 inches high with loops pressed from or welded to face to receive stakes at 36 inches o.c., and steel stakes 15 inches long for each loop.
1. Color: As selected by Architect from manufacturer's full range.

- B. Cork Joint Filler: Preformed strips complying with ASTM D 1752, Type II.
- C. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.

2.3 AGGREGATE SETTING-BED MATERIALS

- A. Graded Aggregate for Base: Sound, crushed stone or gravel complying with ASTM D 448 for Size No. 8.
- B. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
- C. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.

2.4 MORTAR SETTING-BED MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Sand: ASTM C 144.
- D. Latex Additive: Water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by manufacturer for use with field-mixed portland cement mortar bed, and not containing a retarder.
- E. Water: Potable.

2.5 GROUT MATERIALS

- A. Polymer-Modified Grout: ANSI A118.7, sanded grout; in color indicated.
 - 1. Product Type: Either dry mix, containing ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients, or two-component mix, containing liquid-latex and prepackaged dry-grout mix.
- B. Grout Colors: As selected by Architect from manufacturer's full range.
- C. Water: Potable.

2.6 MORTAR AND GROUT MIXES

- A. General: Comply with referenced standards and with manufacturers' written instructions. Discard mortars and grout if they have reached their initial set before being used.

- B. Mortar-Bed Bond Coat: Mix neat cement or cement and sand with latex additive to a creamy consistency.
- C. Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C 270, Proportion Specification.
- D. Latex-Modified, Portland Cement Setting-Bed Mortar: Comply with written instructions of latex-additive manufacturer to produce stiff mixture with a moist surface when bed is ready to receive pavers.
- E. Latex-Modified, Portland Cement Slurry Bond Coat: Mix portland cement, sand, and latex additive to comply with written instructions of latex-additive manufacturer.
- F. Polymer-Modified Grout Mix: Proportion and mix grout ingredients according to grout manufacturer's written instructions.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- B. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.
 - 1. For concrete pavers, a block splitter may be used.
- C. Joint Pattern: Herringbone as indicated on the plans, to match adjacent pavers.
- D. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.
- E. Expansion and Control Joints: Provide foam filler as backing for sealant-filled joints. Install joint filler before setting pavers.
- F. Expansion and Control Joints: Provide joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.
- G. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

3.2 AGGREGATE SETTING-BED APPLICATIONS

- A. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698 laboratory density.

- B. Place aggregate base, compact by tamping with plate vibrator, and screed to depth indicated.
- C. Place leveling course and screed to a thickness of 1 to 1-1/2 inches (25 to 38 mm), taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.
- D. Treat leveling course with herbicide to inhibit growth of grass and weeds.
- E. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars.
- F. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz.
- G. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

3.3 MORTAR SETTING-BED APPLICATIONS

- A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
- B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing setting bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch thickness for bond coat.
- C. Apply mortar bed over bond coat immediately after applying bond coat. Spread and screed to subgrade elevations required for accurate setting of pavers to finished grades indicated.
- D. Mix and place only that amount of mortar that can be covered with pavers before initial set. Cut back and discard setting-bed material that has reached initial set before placing pavers.
- E. Wet brick pavers before laying if the initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
- F. Place pavers before initial set of cement occurs. Immediately before placing pavers, apply uniform 1/16-inch- thick, slurry bond coat to bed or to back of each paver.
- G. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

- H. Grout joints as soon as possible after initial set of setting bed.
 - 1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
 - 2. Tool exposed joints slightly concave when thumbprint hard.
- I. Cure grout by maintaining in a damp condition for seven days, unless otherwise recommended by grout or liquid-latex manufacturer.
- J. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
 - 1. Remove temporary protective coating from brick pavers as recommended by protective coating manufacturer and as acceptable to unit paver and grout manufacturer. Trap and remove coating to prevent it from clogging drains.

END OF SECTION 32 14 00

SECTION 32 18 05 - PLAYING FIELD EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stripping and export of the baseball diamond materials, subsurface sand root zone, gravels and soils, warning track materials, irrigation system, subdrainage system, lower seating bowl drainage piping and existing Bermudagrass sod.
2. Preparation of subgrade finished grade for subdrainage system demolition and removal of selected site elements.
3. Field final finished grading.

B. Related Requirements:

- | | |
|---|------------------|
| 1. Playing Field Subdrainage System: | Section 32 18 06 |
| 2. Playing Field Rootzone and baseball Mixtures | Section 32 18 11 |
| 3. Playing Field Sod: | Section 32 18 13 |

1.2 PLAYING FIELD CONTRACTOR QUALIFICATIONS

- A. Contractor Qualifications shall apply to all work contained within all specification sections beginning with, and numbered 32 18 XX.
- B. Those submitting bids shall be, and have been, actively and directly engaged in constructing high performance sand based baseball fields and renovations for a minimum period of three (3) or more years. As an attachment to the bid, bidder must provide proof of five (5) or more regulation Major League Baseball, Minor League Baseball and/or NCAA baseball field installations which required similar construction techniques, and have been in use successfully for three (3) or more years. The bidder understands that specialized laser grading equipment is required for this project. Further, provide a resume of experience, at the time of receipt of bids, for the project superintendent who will be on the site and actively directing the project on a day to day basis. Project superintendent must possess, on a minimal basis, the same qualifications as listed above. The submission of this information is a material requirement of all 32 18 XX specifications.

Bidders who cannot meet these minimum criteria will be considered non-responsive for the purposes of this project and their bid will not be considered. The Bidder must provide minimum five names and telephone numbers of Architects, and owners who can be contacted to verify the satisfactory completion of previous work.

- C. Project Conditions: The playing field contractor is strongly urged to review the Geotechnical and soils report prior to bidding. No additional compensation will be made to the playing field contractor for soil conditions clearly defined in the geotechnical report. Locate known existing underground utilities in the areas of work.
- D. If utilities are to remain in place, provide adequate means of protection during earthwork operations. Should uncharted, or incorrectly charted piping or other utilities be encountered during excavation, consult with the Architect and utility owner for directions. Cooperate with the Architect and utility companies in keeping utilities in operation. Repair damaged utilities to the satisfaction of the owner. Do not interrupt existing utilities serving occupied or used facilities except when permitted in writing by the Architect and then only after acceptable temporary utility services have been provided and a schedule for outages has been approved by the Architect.
- E. The project scope includes a full renovation of the baseball field. Establishing the finished subgrade and final finished grades of the playing field shall be accomplished as a part of this section. The subgrade field elevations of the sodded areas of the field are approximately 15" lower than the proposed finished grade of the field. The subgrade field elevations of the skinned infield and warning track areas of the field are approximately 9" lower than the proposed finished grade of the warning track skinned infield. Upon removal of the existing playing field materials, playing field contractor shall verify the proper subgrade elevations with a grade certification prior to the installation of the subdrainage piping (see spec. 32 18 06). Subgrade certification shall be provided by a registered state of North Carolina professional engineer. The Owner's representative shall approve this grade certification, in writing, prior to the commencement of the installation of the subdrainage and trench/channel drainage piping systems. Notify the Owner's representative immediately, in writing, of any discrepancies.
- F. Locate known existing underground utilities in the areas of work. Refer to the plans and specifications regarding utilities that are to remain in place and provide adequate means of protection during earthwork operations. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult with the Owner's representative and utility owner for directions.

Cooperate with the Owner's representative and utility companies in keeping utilities in operation. Repair damaged utilities to the satisfaction of the Owner. Do not interrupt existing utilities serving occupied or used facilities except when permitted in writing by the Owner's representative, and then only after acceptable temporary utility services have been provided, and the Owner's representative has approved a schedule for outages. Demolish and completely remove from the field existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off and capping of services if these lines are active.

- 1.3 Protection of Persons and Property: Barricade open excavations resulting as a part of this work, and install warning lights. Operate warning lights as recommended by authorities having jurisdiction. Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
- 1.4 Cleaning: Contractor shall clean and maintain adjacent streets to meet requirements of authorities having jurisdiction

PART 2 - PRODUCTS

- 2.1 Soil Materials
 - A. Soil materials to be utilized to finish the laser graded subgrade, whether from sources on or offsite, must be reviewed and approved by the Owner's representative as suitable for intended use and specifically for required location or purpose.

PART 3 - EXECUTION

- 3.1 Examination
 - A. Site visit: Visit and inspect site and take into consideration known or reasonably inferable conditions affecting work, prior to bidding. Failure to visit the site will not relieve the Contractor of furnishing materials or performing work required.
- 3.2 Preparation
 - A. Field engineering for benchmarks, monuments, reference points and layout of the work shall be verified prior to commencing work.

Coulter Jewel Thames PA has provided a benchmark, survey dated 04/18/13. A copy of this plan is available through the CM/General Contractor.

B. Protection

1. Maintain soil under foundations and pavements at natural moisture content as may be required.
2. Provide and maintain slopes, crowns and ditches in excavation to ensure satisfactory surface drainage at all times. Provide temporary drainage facilities to prevent water from draining into excavations.
When work is completed, restore temporary ditches or cuts to original grade or finish grade as indicated.
3. Bailing or Pumping: Keep excavations free from water at all times. Take measures and furnish equipment and labor necessary to control water flow, drainage and accumulation of water as required to permit completion of work under this Section to avoid damage to work. Discharge water into the existing storm drainage system and or subdrainage piping system as approved by the Owner's representative.

3.3 Excavation

- A. Area Excavations: Excavate site as required to accommodate aggregate layers as indicated on the drawings. All excavated materials shall be completely removed from the site at the expense of the playing field contractor.
1. Subdrainage pipe trenches: Bottoms of full width required. If through error, trenches are carried deeper than required, fill excess depth with compacted fill as directed at Contractor's expense.
 2. Subgrades: If debris, soft spots or loose or excessively moist areas are found at the bottom of any excavation, immediately report condition to Owner's representative who will determine the corrective work if necessary.
 3. Unsuitable subgrade material: If unsuitable bearing materials are encountered at the required subgrade elevations, carry excavations deeper and replace the excavated material as directed by the Owner's representative's representative with suitable material from the onsite stockpile.

4. Subgrade certification: When excavation has reached required subgrade elevations, and is laser graded, playing field contractor to certify grades provided by a registered state of North Carolina professional engineer to within $\pm \frac{1}{2}$ " with field engineers 25' X 25' grid report. Provide certified survey in PDF format and notify the Owner's representative who will review field engineer's grade survey certifications for sign off.

B. Stability of Excavations:

1. Sides of excavations shall comply with all codes and ordinances having jurisdiction. Shore and brace sidewalls for stability of material excavated.
2. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

C. Dewatering:

1. Prevent surface water from flowing into excavations and from flooding project site and surrounding areas.
2. Do not use footing, foundation or utility trench excavations as temporary drainage ditches.

D. Cold weather protection:

1. If necessary, protect excavation bottoms against freezing when atmospheric temperature is less than 35 F if work must continue to meet schedule.

E. Excavated materials:

1. Playing Field Contractor will completely remove the existing playing field sod, warning track top mix, rootzone sands, gravel layers, existing subdrainage and lower seating bowl drainage systems (as may be required), irrigation piping, heads and valves, (salvage all irrigation heads, valves, quick couplers and gate valves; provide to Owner's turf manager).
2. All excavated materials shall be removed to an offsite location at the expense of the contractor.

3.4 Compaction

A. Compaction requirements:

1. Compact each layer to minimum of the following Standard Proctor Densities by ASTM D698.

- a. Utility trench backfill 95%
- b. Subbase or subgrade 95%

Owner shall be responsible for compaction testing of the subgrade soils beneath the renovated portions of the field. Notify Owner 48 hours in advance of anticipated request by the playing field contractor for compaction testing.

Approval, in writing, shall occur prior to the installation of the subdrainage piping system for the field. Compaction tests shall occur for every 10,000 s.f. of surface area of the field (approximately 12) and shall be provided immediately to the Owner's representative for review and comment.

Playing Field contractor will be responsible for payment or retesting for failed tests.

3.5 Finish Grading

- A. General: Cut and fill all areas to elevations and tolerances specified. Leave graded surface clean, free from rubbish and large clods and laser graded.
- B. Subgrade under playing field: Finish grade to subgrade elevations indicated on the Drawings. Tolerance: $(\pm) 0.04'$ ($\frac{1}{2}"$) **(25' X 25' grid survey required for certification)**.
- C. Finish grade at top of sand layer, clay infield and warning track: Laser graded elevations of the field shall be within plus 0.00 or minus 0.75 inch with no variations of more than 0.25 inch in 25 feet of the designed elevations. **Provide certified as-built drawings (25' X 25' grid survey required for certification) in PDF format of final finished grade elevations for Owner's representative approval prior to installation of the selected natural turf.**

3.6 MAINTENANCE

- A. Protection of graded areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris. Repair and re-establish grades in settled, eroded and rutted areas to specified tolerances.
- B. Reconditioning compacted areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, reshape and compact to required density prior to further construction.

Settling: Where settling is measurable or observable at backfilled or filled areas during general project warranty period, remove surface (pavement, lawn or other finish), add appropriate backfill material, compact and replace surface treatment. Restore appearance, quality and condition of surface to match adjacent work and eliminate evidence of restoration to greatest extent possible.

END OF SECTION 32 18 05

SECTION 32 18 06 – SUBDRAINAGE SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Work shall include all labor, materials and equipment to remove and replace the existing subdrainage system, and to install new field under drainage piping system, trench and channel drains as indicated on the Field Subdrainage Plan, and as herein specified.
- B. Related Work.
 - 1. Playing Field Earthwork: Section 32 18 05
 - 2. Playing Field Irrigation System: Section 32 18 08
 - 3. Playing Field Sand Rootzone and Baseball Materials Section 32 18 11
 - 4. Playing Field Sod: Section 32 18 13

PART 2 - PRODUCTS

2.1 MATERIALS

- A. PERFORATED AND SOLID DRAIN PIPE - Perforated and solid drain pipe shall be high density corrugated polyethylene heavy duty pipe and shall be manufactured in conformance with the latest AASHTO specifications of M294 Type S (8" dia. and greater) and AASHTO M252 (4" dia. and less). **ADS N12 or Hancor "smooth wall interior" are acceptable materials. Coiled pipe is not an acceptable material.**
- B. JOINTS AND FITTINGS - Pipe joints and fittings shall conform to AASHTO M294 and AASHTO M252. Couplers shall cover not less than one full corrugation on each annular section of pipe.
- C. GRAVEL BLANKET AND PIPE BEDDING MATERIAL – Gravel Blanket (4" minimum depth) and pipe bedding material for the playing field shall generally be 2.0 to 6.0 millimeters in particle size and conform to the criteria listed below. Gravel components shall not have an LA Abrasion (ASTM-C131) value exceeding 40, and a loss not exceeding 12% as determined by a sulfate soundness test (ASTM C88). The gravel shall be a crushed granite or washed pea gravel, free of lumps of clay, soil or vegetative material. Limestone gravel is not an acceptable material. Provide quart bag sample and electronic (PDF) copies of the sieve analysis/testing data to Owner's representative's representative prior to work commencement meeting the following:

Sieve Size	Diameter	Retained Sieve Percentage
1/2"	12.5mm	0
3/8"	9.5mm	less than 5.0%
1/4"	6.3 mm	20% to 30%
5	4.0mm	40% to 50%
10	2.0mm	0% to 20%
less than 10	less than 2.0	less than 10%

Gravel samples shall be simultaneously submitted with the sand rootzone, listed in specification section 32 18 11, to a soils testing laboratory for comparison to the sand root zone material.

Final selection of the gravel bedding material shall be based upon the gravel meeting the criteria as established by USGA D15-D85 bridging requirements, when compared to the approved sand root zone material (see section 32 18 11).

Suggested (but not limited to) gravel suppliers:

Morgan Sand and Gravel

Approved gravel shall be tested for conformance with this specification in 400 ton lots prior to delivery to the site. Suggested soils testing laboratories:

A. McNitt & SerenSoil, LLC	Tifton Labs
306 Ravendale Road	1412 Murray Avenue
Pennsylvania Furnace, PA 16865	Tifton, GA 31794
(814) 364-2792 voice/fax	(229) 382-7292

- D. GEOTEXTILE FILTER FABRIC: Nonwoven filter fabric consisting of long-chain synthetic polymers, composed of at least 85% by weight polyolifins, polyesters or polyamides and exhibiting the following physical properties:

Grab test:	90 lbs minimum	ASTM D4632
Puncture test	60 lbs minimum	ASTM D4833
Burst strength	215 psi minimum	ASTM D3786
Trapezoid strength	42 lbs minimum	ASTM D4533
Permeability	0.1 cm/sec minimum	ASTM D4491
Apparent opening	#50 sieve size	ASTM D4751

Myrafi 140 N (or equivalent), is an acceptable material.

- E. Clean Out Valve Boxes/Six Inch Piping – All six (6") pipe terminations shall be installed in suitable 10" diameter valve boxes per the details on the plans. All cleanout boxes shall be as manufactured by Ametek or approved equal.
- F. Clean Out Valve Box/Twelve Inch Piping - Twelve (12") cleanout shall be installed with a 24" cast iron manhole cover with frame on a six inch (6") thick concrete ring (See detail G-PF-2.1)) for a total of one (1) cleanout using this configuration.

- G. TRENCH DRAINS- Trench Drains to be installed in front of each of the dugouts shall be as manufactured by Stegmeier, Corp., 1-800-382-5430. Trench Drains shall be Flowmaster 3 A/T Deck Drain. Trench drains shall be field cut to fit dimensions shown on the plans and installed per the manufacturer's recommendations and the details on the plans. See detail H-PF-2.i.
- H. Channel Drains-Channel Drains shall be as manufactured by ACO Sport Drains. Channel Drains shall be ACO Sport Model # 4002 with Black Plastic Grates, complete with plastic cleanout trash buckets. Channel drains shall be field cut to fit dimensions shown on the plans and installed per the details on the plans. See Detail J-PF-2.1 Concrete for Channel Drains (2500 psi min.) shall be red in color to match color of warning track top mix. Submit color chip for approval.
- I. Tarp Drains – Tarp drains shall be installed as indicated on the plans and per detail F-PF-2.1.
- J. 48" dia. Manhole – A new 48" precast manhole shall be provided and installed per the plans and the details provided. See Detail K-PF-2.1.
- K. Trench and Channel Drainage Piping - New piping for the new Trench and Channel Drains shall be Schedule 40 PVC pipe with 45 degree connection from the trench drains to the main collector pipe. The main collector pipe shall be new HDPE pipe as noted above in 2.1 A, or approved equal. All pipe shall be permanently marked with the manufacturer's name.

PART 3 - SUBMITTALS

3.1 SUBMITTALS

- A. After award of contract: Prior to construction, submit manufacturer's product data on clean out valve boxes, drainage piping, fittings and accessories, channel/trench drains, 48" manhole and a one quart bagged sample of clean-washed drainage gravel and the required testing data. Electronic submittals in PDF format are required, in one singular submittal for this specification section. Submittals are to be submitted to the Owner's representative. Submittals for the trench and gravel bedding materials shall be submitted simultaneously with the sand rootzone (spec 32 18 11) so that all materials can be compared and verified to be compatible with each other.

PART 4 – EXECUTION

4.1 INSTALLATION

- A. Playing field contractor shall commence the underdrainage work upon inspection and approval in writing (by the Owner's representative) of the subgrade of the field which is to be brought to $\pm .04'$ ($\frac{1}{2}"$) of planned subgrades. See Spec. 32 18 05. Subgrade elevations of the field shall conform to, and mirror the finish grades shown on plans (sheets PF-1 and PF-1.1).
- B. Certified survey verification of the subgrade elevations of the playing field, by a registered North Carolina surveyor, shall be provided to the Owner's representative by the playing field contractor, and approved in writing, prior to the installation of the subdrainage piping system. See specification section 32 18 05. Notify the Owner's representative, in writing, of any discrepancies found in the subgrade before pipe work commencement.
- C. The location of each run of pipe shall be staked out and laser surveyed prior to trenching. Install geotextile filter fabric to bottom and sides of trenches as indicated on the installation details. Pipe trench shall be wrapped on all sides beneath the skinned infield area only. All pipe shall be carefully placed in the trenches with bedding material installed per plans and details. The interior of pipes shall be kept free from dirt and debris, and when pipe laying is not in progress, open ends of pipes shall be closed by tape or other approved means.
- D. All pipe shall be laid to drain in accordance with the plans. All 4" subdrainage piping shall be emptied into the 8", 12" and 15" diameter perforated piping as shown on the plans and at the elevations listed per the subdrainage plan.
- E. Connections into the new 48" storm manhole shall be made at the planned elevations and grouted appropriately. Under no circumstances shall equipment other than low ground pressure equipment be driven over installed subdrainage trenches without adequate bridging of the trenches. Failure to adequately bridge subdrainage trenches may result in damage to the piping and be cause to remove the entire run of pipe for inspection of possible damage.
- F. Install the playing field 8", 12" and 15" perforated drainage piping as shown on the plans. Connect the new 12" and 15" solid and perforated pipes shown into the new 48" manhole as indicated.
- G. Coordinate all pipe trenching and installation with irrigation piping and utilities and storm and sanitary sewer systems. If conflicts exist, modify irrigation lines as required and protect the storm/sanitary sewer, paving and other existing utilities from damage.
- H. Remove all excess waste materials and soils off of field and maintain original subgrade elevations. Protection and repair of existing paved surfaces and utilities shall be the responsibility of the Playing Field Contractor.

Keep up to date as-built documents, as the job progresses and make available to Owner's representative for inspection at all times. Revise drawings as required to indicate field changes made during installation on reproducible plans.

PART 5 - GUARANTEE

5.1 Guarantee

- A. All materials installed shall be new materials and the workmanship shall be guaranteed for a period of one (1) year, beginning at the date of final acceptance by the Owner's representative and/or the Owner's representative.

END OF SECTION 32 18 06

SECTION 32 18 08 - PLAYING FIELD IRRIGATION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Work shall include all labor, materials, and equipment as well as obtaining fees and permits as may be required to complete the irrigation system as indicated on the Irrigation Plan and as herein specified. The work shall comply with the requirements of all legally constituted authorities having jurisdiction.
- B. Related Sections:
 - 1. Playing Field Earthwork: Section 32 18 05
 - 2. Playing Field Subdrainage System: Section 32 18 06
 - 3. Playing Field Sod: Section 32 18 13

1.2 QUALITY ASSURANCE

- A. REQUIREMENTS - Work shall be performed in accordance with the best standards of practice relating to the various trades and under the continuous supervision of an experienced irrigator capable of interpreting the Drawings and Specifications. The Playing Field Contractor shall notify the Owner's representative as soon as any discrepancies between the Drawings and Specifications are discovered.
- B. COORDINATION - Coordinate work of this section with earthwork, subdrainage piping system, existing plumbing, and electrical systems.
- C. EXPLANATION OF DRAWINGS
 - 1. It is intended that the Drawings and Specifications provide for an efficient and complete irrigation system for use in accordance with the Manufacturer's recommendations and meeting the Owner's representative's approval without additional cost to the project.
 - 2. All plot and/or scale dimensions are approximate. Before beginning any phase of work, the Irrigation Contractor shall check and verify all dimensions on the Drawings and shall notify the Owner's representative of any discrepancies.
 - 3. The Irrigation Contractor shall verify the authenticity of all finish grades within the project area for ensurance of proper coverage of the sprinkler system. Contractor shall verify the existing onsite water pressure. System design is based upon 85 psi static pressure at the point of connection at the field, with a minimum operating pressure at the irrigation head of 70 psi.

PART 2 – PRODUCTS

1.2 MATERIALS

A. PIPE

1. MAINLINE - All mainline pressure pipe shall be Schedule 40 PVC pipe, as manufactured by Continental Plastics Industries, Inc., or approved equal. All pipe shall be continuous, new and permanently marked with the manufacturer's name. All PVC pipe shall conform to the United States Department of Commerce commercial standard ASTM D-1785, National Sanitation Foundation No. 14. Pipe shall be sized per the Irrigation Plan.
2. MAINLINE PRESSURE PIPE FITTINGS AND CONNECTIONS – All PVC mainline pressure pipe fittings shall be manufactured of ductile iron, Grade 65-5-12 in accordance with ASTM A-536. Fittings shall have deep bell push-on joints with gaskets meeting ASTM F-477. Fittings shall be HARCO DEEP BELL as manufactured by The Harrington Corp., of Lynchburg, VA. Transition gaskets are not allowed.
3. LATERAL LINE, NON-PRESSURE FITTINGS AND CONNECTIONS - All lateral pipe shall be Schedule 40 PVC pipe, as manufactured by Continental Plastics Industries, Inc., or approved equal. All pipe shall be continuous, new and permanently marked with the manufacturer's name. All PVC pipe shall conform to the United States Department of Commerce commercial standard ASTM D-1785, National Sanitation Foundation No. 14. Pipe shall be sized per the Irrigation Plan.
4. FITTINGS AND CONNECTIONS - All PVC pipe fittings shall be ASTM D-1784 Schedule 40 molded fittings suitable for solvent weld or threaded connections.
5. Slip fitting socket taper shall be of a certain size so that a dry, unsoftened pipe conforming to these specification provisions can be inserted no more than halfway into the socket. Plastic saddle and flange fittings shall not be permitted.

C. IRRIGATION HEADS

1. Rotary Irrigation Heads - Hunter I-40, 6" pop-up, with stainless steel risers. Rotary head shall be of the gear- driven type. The unit shall have a one inch MPT inlet. Nozzle selection shall be per the plans. All irrigation heads shall receive pre-assembled triple swing joint assemblies per the details provided.
2. General - Irrigation heads shall be of the type and size as indicated on the Drawings and Specifications.

3. All heads of a specific type of function in the system shall be of the same manufacturer and shall be marked with the manufacturer's name and identification in such a position that they can be identified without being removed from the system.

D. VALVES AND KEYS

1. Electric Remote Control Valves - The electric remote control valves shall be Hunter ICV plastic valves. All valves shall be complete with two wire decoder modules and wiring. Size, location and installation shall be per the irrigation plan and details.
2. Irrigation Quick Coupling Valves - The quick coupling valves, Rainbird #7, installed where indicated on the Drawings, constructed of heavy-duty brass construction. The body shall be one piece construction and provide low friction loss through the valve and highest operating efficiency.
 - a. The quick coupling valves shall have spring-loaded rubber covers and stainless steel internal valve springs.
 - b. The quick coupling valves for the indicated areas shall have a 1.5 inch size bottom female pipe thread connection and a 1 inch size top female pipe thread connection.
 - c. The quick coupling valves shall be located in 10" diameter valve boxes, with synthetic turf glued to the lids as indicated on the plans.
3. Irrigation Quick-Coupling Valve Keys - The valve keys shall be of the same manufacturer as the quick coupling valves and shall be of proper size to fit the valves as previously specified. The key shall have male and/or female thread, as specified, for the valve connection. The Irrigation Contractor shall furnish the Owner with four keys, complete with hose swivels.
4. Control Valve Boxes - New control valves shall be installed in 12" standard valve boxes with locking covers as shown on the irrigation plan and details. All valve boxes shall be as manufactured by Ametek or approved equal. Valve boxes shall be installed on a minimum of one (1) cubic foot base of washed gravel for proper foundation of box and easy leveling of box to proper grade and also to provide proper drainage of the valve box. All valve boxes shall be provided with proper length and size extensions, wherever required (see details).
5. Quick Coupling Valve Boxes - Quick coupling valves shall be installed in 10" round valve boxes with locking covers as shown on the irrigation plan and details. All valve boxes shall be as manufactured by Ametek or approved equal.

Valve boxes shall be installed on a minimum of one (1) cubic foot base of washed gravel for proper foundation of box and easy leveling of box to proper grade and also to provide proper drainage of the valve box. All valve boxes shall be provided with proper length and size extensions, wherever required (see details). Valve box lid shall be covered with synthetic turf (Field Hockey typ.). Submit sample of artificial turf with other submittals required for this specification section.

E. AUTOMATIC CONTROLLER AND CONTROL WIRING

1. Automatic Controller - Automatic controller shall be a Hunter ACC 99D, wall mounted, complete with a Hunter ICR-KIT remote. Controller shall be located in a stainless steel, weather proof and locking housing and shall be installed as indicated on the plans. Electrical power (120v, 5a) supply and installation to the automatic irrigation controller shall be supplied by others.
2. Irrigation Control Wiring - All new wiring to be used for connecting the automatic controller to the electric remote control valves shall be 14 AWG, 2MM2 standard decoder cable.

F. BOOSTER PUMP/STATION

1. Refer to the civil engineers' utility plan (Sheet C 500) prepared by Colter, Jewel, Thames for more information regarding this item.

2.2 ADDITIONAL MATERIALS

- A. Provide as a provision of this specification the following additional materials to be used for attic stock by the Owner and/or his assigns.
1. One (1) full case of I-40 rotary irrigation heads as specified above.
 2. Three (3) ICV 101G automatic control valves.
 3. Three (3) ICV 151G automatic control valves.
 4. Three (3) ICV 201G automatic control valves.

PART 3 SUBMITTALS

3.1 SUBMITTALS

- A. After award of contract: Prior to construction, submit manufacturer's product data on each type of irrigation product.

Electronic submittals in PDF format are required, in one singular submittal for this specification section. Submit to the Owner's representative for approval.

PART 4 – EXECUTION

4.1 INSTALLATION SCHEDULE AND IMPLEMENTATION

- A. The irrigation work shall be scheduled by the Irrigation Contractor in such a way that the new lower bowl drainage piping and new subdrainage piping installation is protected.
- B. The location of each run of pipe, mainline or laterals, and all irrigation heads and valves, shall be staked out by the Irrigation Contractor prior to trenching. All pipe, valves, fittings, etc., shall be carefully placed in the locations as shown on the plans and details. The interior of pipes shall be kept free from dirt and debris and when pipe laying is not in progress, open ends of pipes shall be closed by approved means.

4.2 INSPECTION

- A. Notice. - When the Irrigation Contractor is prepared for one of the required inspections, he shall give the Owner's representative adequate notice to visit the site and perform the inspection. This does not preclude the right of the Owner's representative to make informal inspections at any time during the work of this section. The required inspections for which the Irrigation Contractor must notify the Owner's representative are as follows:
- B. Irrigation Equipment Location Staking - The Owner's representative or assigns shall inspect the proposed locations of all irrigation lines and heads for conformance to the Drawings and Specifications. The Owner's representative reserves the right to move, shift or adjust any or all of the proposed locations to better achieve the design intentions as shown on the Drawings.
- C. Wiring Inspection - When the wiring has been installed, the Owner's representative shall inspect for conformance to these Drawings and Specifications.
- D. Coverage Test - After the sprinkler heads have been installed and backfilling operations are complete, the Irrigation Contractor, in the presence of the Owner's representative, shall perform a coverage test to determine if the irrigation system reaches all parts of the areas to be sodded.

4.3 STAKING AND LAYOUT

- A. The Irrigation Contractor shall provide all materials necessary for the staking of the irrigation system. All irrigation heads are to be flagged for the Owner's representative's observation.

Contact the Owner's representative, in advance, and request inspection of the layout. The Owner's representative will observe layout and indicate any changes as needed.

4.4 TRENCHING

- A. PVC main and lateral line piping shall be installed in the existing subgrade soils. A twelve inch (12") minimum depth over non-pressure lateral lines is required. PVC pressure mainline pipe shall be located as shown on the plans. Minimum cover over mainline pressure piping shall be eighteen inches (18") from the top of the pipe. In rocky or trash conditions, mainline piping shall be bed and backfilled with sand.

4.5 PLASTIC PIPELINE FITTINGS

- A. Installation - All workmanship and materials shall be in conjunction with all applicable local codes and ordinances of legally constituted authorities; where the provisions of these Specifications exceed such requirements, these Specifications shall govern.
- B. All plastic pipe shall be installed in a manner so as to provide for expansion and contraction as recommended by the Manufacturer.

4.6 LINES UNDER PAVEMENT

- A. Provide sleeves (as required) using PVC pipe sized as per the Drawings under all walks and paving. Locations and depths of sleeves shall be noted on the As-Built Irrigation Plan. Backfill trenches under paving, asphaltic concrete or concrete with 1.5 sacks per cubic yard of cement stabilized sand and compact in six inch (6") layers to ninety-five percent (95%) Standard Proctor density, using manual or mechanical tamping devices. Leave trenches flush with subgrade level to receive paving.

4.7 CONTROL WIRING

- A. Control And Common Wire Installation – Control wire shall be installed beside the mainline and in sleeves where required. Wire shall then be placed as loose as possible to allow for expansion and contraction of the wire. Verification of wire types and installation procedure should be checked to conform to local codes.

4.8 AUTOMATIC CONTROLLER

- A. The Automatic Controller shall be installed in the location indicated on the plan and per the details provided.

4.9 VALVES AND VALVE BOXES

- A. Control Valves And Quick Coupling Valves - Control valves shall be installed in 12" rectangular boxes per the details and quick coupling valves shall be installed in 10" round boxes with swing joint assemblies as per the Details.
- B. Valve Boxes - Control valve boxes shall be installed on a minimum of one (1) cubic foot base of clean gravel for proper foundation of box and easy leveling of box to proper grade and also to provide drainage of the valve box.

4.10 IRRIGATION HEADS

- A. Unless otherwise specifically designated on the Drawings, the installation of irrigation heads shall include the excavation and backfill, furnishing, installing and testing of risers, fittings and irrigation heads in accordance with the Drawings and Specifications. All rotary irrigation heads shall be installed with preassembled triple swing joint assemblies as per details.

4.11 FLUSHING AND TESTING

- A. After all new irrigation piping is in place and connected for a given section, and prior to the installation of the irrigation heads, all control valves shall be opened and a full head of water used to flush out the system. Irrigation mainline and automatic control valves shall be pressure tested for a period of 24 hours at 100 psi. Repair leaks as required.

4.12 ADJUSTMENTS

- A. Responsibility - The Irrigation Contractor and his assigns shall be responsible for properly making adjustments during the maintenance period.

4.13 PROTECTION AND REPAIRS

A. PROTECTION OF PROPERTY

- 1. It shall be the responsibility of the Irrigation Contractor to protect and preserve any existing structures, concrete walls etc., from damage during irrigation construction. If damage does occur, all damage shall be completely repaired or restored by the Irrigation Contractor at no additional cost to the project.

4.14 CLEAN UP

- A. Perform clean up as a continuous operation throughout the duration of the work.

4.15 FINAL INSPECTION

- A. When the Irrigation Contractor is satisfied that the system is operating properly, that it is balanced and adjusted, and that all work and cleanup is completed, he shall notify the Owner's representative that he is prepared for Final Inspection.

At the given time, the sprinkler system will be inspected by Owner's representative for the following:

- B. Sprinkler Heads
1. Heads adjusted to grade
 2. Heads properly aligned
 3. Nozzles properly adjusted
 4. Broken heads replaced
 5. Missing heads replaced
 6. Broken risers replaced
- C. Gate valves and control valves operating properly and not leaking.
- D. Controller operating properly and programmed. Any inconsistencies to the Specifications will be noted by the Owner's representative and a written copy of corrections will be given to the Irrigation Contractor. The Owner's representative will not accept the system until the corrections from the final inspection have been made by the Irrigation Contractor.

PART 5 - GUARANTEE

5.1 IRRIGATION SYSTEM

- A. The new irrigation system workmanship and materials shall be guaranteed for the period of one (1) year from the date of written final acceptance of work. The irrigation contractor shall be responsible for proper winterization of the irrigation system during the one (1) year guarantee period. This shall include one winterization and one spring charge-up of the system. Should any trouble develop within the time specified above due to faulty materials or material, the defect shall be corrected by the Irrigation Contractor without expense to the Owner. The Irrigation Contractor is not responsible for repair of sprinkler system due to vandalism, fire, theft or acts beyond the Contractor's control.

END OF SECTION 32 18 08

SECTION 32 18 11 – PLAYING FIELD SAND ROOTZONE AND BASEBALL MIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Work shall include all labor, materials, and equipment necessary to complete the playing field root zone system, and playing field materials and mixtures, as indicated on the plans and as herein specified.
- B. Related Work:
- | | |
|--------------------------------------|------------------|
| 1. Alternates | Section 01 23 00 |
| 2. Playing Field Earthwork: | Section 32 18 05 |
| 3. Playing Field Subdrainage System: | Section 32 18 06 |
| 4. Playing Field Sod: | Section 32 18 13 |

PART 2 - PRODUCTS

2.1 MATERIALS

- A. ROOTZONE SAND - The sand shall be a silica sand, non-calcareous, clean and processed and shall meet the following particle size criteria. Calcareous sand meeting the following criteria will be acceptable only if proven that a local source within a 150 mile radius of the project cannot be found to supply non-calcareous material.

	Sieve Mesh	Diameter (mm)	Allowable range % retained
Gravel	10	>2.00	Less than, equal to 5%
Very Coarse	18	1.00-2.00	0 to 20% w/ gravel
Coarse	35	0.50-1.00	at least 60%
Medium	60	0.25-0.50	particles in this range
Fine	100	0.15-0.25	20% maximum
Very Fine	270	0.05-0.15	5% maximum
Silt		0.002	5% maximum
Clay		less than 0.002	3% maximum

In addition, there should be 100% passing the No. 5 screen (4mm), and no more than 10% combined very fine, silt, and clay, and the sand should have a uniformity of coefficient (Cu) of 2.5 to 3.5. Submit samples to testing agent for analysis to assure conformance with 1993 USGA protocol and this specification. See Part 4 for suggested testing laboratories.

- B. ORGANIC MATERIALS - Organic materials shall be "Dakota" Reed Sedge Peat or Fafard Peat and must be at least 80% organic material, well decomposed and uniform in texture.

Organic materials shall be low enough in silt and clay content to hold the final rootzone mixture to less than 5% silt and less than 3% clay. pH of organic materials shall be 6.0 to 7.0 and material shall be free from extraneous materials such as sticks, roots, rocks, etc. Peat content will be verified using the loss on ignition (ASTM D 2974-87 Method D) determination process.

Suggested (but not limited to) Rootzone sand and peat suppliers:

Morgan Sand and Gravel

- C. Rootzone Mixture - Organic range of 0.4 to 0.6 organic matter on a dry weight basis. Approximately a 90% sand/10% peat ratio will be required. The sand peat mix shall be mixed off-site to a uniform consistency using a mechanical blender designed for producing high performance sand based rootzones. Final percentage of peat in the sand rootzone blend will be determined through laboratory testing. Using 1993 USGA protocol (ASTM F1815), the final rootzone mixture shall comply with the following criteria:

Water retention shall be based upon 25 cm tensions as follows:

Infiltration Rate, inches per hour:	15-25
Bulk Density, grams/cc:	.2 to 1.6
Total Porosity, percent:	35 to 55%
Saturation percentage @ 25 cm tension:	35 to 65%
Uniformity of Coefficient	2.5 to 3.5

- D. Natural Turf Soil Amendments And Fertilizers – Soil Amendments and fertilizers shall be as determined by final lab analysis of the rootzone sand, submitted to the suggested agronomic testing lab, by the Playing field contractor, with review and final written specifications prepared by the Owner's representative. An allowance of \$7,500 (materials cost only) shall be included in the base bid for testing and purchase of soil amendments, and fertilizers incorporated into the sand rootzone prior to sodding. Testing and installation/tilling of these materials in to the top 2-3" of the sand rootzone shall be included by the playing field contractor. Suggested agronomic testing lab:

Servi-Tech Labs
1816 East Wyatt Earp
Dodge City, KS 67801
(316) 227-7123.

- E. DuraEdge Pro Infield Clay - Infield skinned area and baselines shall be installed and laser graded to a compacted depth of 6". Infield Mix shall be pre-mixed and processed to approximate percentages of 60% sand, 18% silt and 22% clay mixture, and red in color. Submit samples and testing analysis to Owner's representative prior to work commencement (see details). Skinned In-field shall be conditioned by the playing field contractor, at the direction of the Owner's turf manager, with ¼" (~12 tons) of Red Pro's Choice Premium Infield Conditioner (or equivalent).

An additional 15 tons of bagged Infield conditioner shall be stockpiled on the site for future use. Further, twelve (12) tons of additional skinned infield clay mix shall be stockpiled at the direction of the Turf Manager for future use. Supplier of infield clay shall be Natural Sand Co. (866) 867-0052

- F. Pro's Choice Pro Mound Clay –Mound Clay (red) shall be pre-mixed and processed to an approximate 35% clay, 15% silt and 50% sand mixture. Submit sample and testing analysis to Owner's representative for approval prior to work commencement (see details). Mound Clay may be bagged or bulk. Five (5) tons of additional pitcher's mound clay shall be stockpiled in the bins provided for future use by the turf management personnel.
- G. Home Plate Soil Material- Home plate materials shall be the same clay as the mound mix.
- H. Homeplates and Running Bases - Provide Jack Corbett original MLB "Hollywood" 15" X 15" bases for 1st, 2nd and 3rd bases and Hollywood Bury-All Homeplates, as noted on plans for the main field diamond and both bull pens. Other than the bases needed to construct the main playing field diamond and bullpens, provide for three (3) additional and complete sets of bases, homeplates, and pitching rubbers to be utilized for future use.
- I. Pitching Rubbers- Bull Dog Professional pitchers box 4-way pitching rubbers as supplied by Bull Dog Field Equipment.
- J. Warning Track Material - The warning track shall be red crushed brick material installed to a minimum compacted depth of 4" over a 5" depth of crusher fines. Submit sample and testing analysis to Owner's representative for approval prior to work commencement (see details). Twenty five (25) tons of additional warning track top material shall be stockpiled on the site for future use by the turf management personnel. Supplier General Shale.

ALTERNATE #5: Alternate Red Lava Rock Warning Track materials per specification 012300-Alternates.

Provide additive alternate pricing to provide red lava rock warning track materials in lieu of the crushed brick warning track materials listed above:

- 1. Base Bid: Provide crushed brick warning track material as indicated above from General shale Co.
- 2. Alternate: Provide alternate red lava rock warning track materials as indicated below and as follows:
 - a. Alternate No. 5a: Provide Country Stone Red Lava Rock (309) 787-1744 in lieu of crushed brick warning track materials.
 - b. Alternate No. 5b: Provide Natural Sand Co. Dura Trax Warning Track Mix (866) 867-0052 in lieu of crushed brick warning track material.

PART 3-SUBMITTALS

4.1 Submittals

- A. After award of contract: Prior to construction, submit manufacturer's product data and material's samples on sand rootzone blend, infield clay mixture, mound clay, warning track material, warning track crusher fines underlayment rock, pitching rubbers and bases. Submittals for the trench and gravel bedding materials shall be submitted simultaneously with the sand rootzone so that all materials can be compared and verified to be compatible with each other. Submit electronic copies (in PDF format) in one singular submittal, with other submittals required for this project.

PART 4 – EXCECUTION

4.1 INSTALLATION

- A. Field Layout – Layout shall be performed utilizing GPS survey instruments. It is a requirement that the skinned infield area, baselines, pitching mound, home plate area, bullpens and warning track be formed utilizing wood and/or steel forms as indicated on the drawings. Contact Owner's representative for an inspection of the forms prior to placement of the required materials. Further, coordinate the layout of the field, and this work with other trades on the site, and the owner's turf manager as may be required. This work shall include the adequate compaction of all materials to the depths specified on the plans and details, to include placement and compaction of the edges once the forms have been removed.
- B. Rootzone Blending And Testing - Based upon the final lab analysis of the sand and peat mixture, these materials shall be blended at an offsite location utilizing a mechanical blender designed for producing high performance sand based rootzones.
- C. Final rootzone blend shall be tested using USGA testing protocol, by one of the suggested soil's testing laboratories listed below. Individual sand and peat components shall be submitted to the testing laboratory to determine the appropriate mixing ratios. The playing field contractor shall have the selected rootzone supplier make up a test mix using the suggested ratios and resubmit the test mix to the lab. The final blend shall be approved by the Owner's representative prior to bulk blending of entire rootzone. Upon approval (by the Owner's representative) of the final rootzone blend, the sand/ soil rootzone shall be tested in 1000 ton lots PRIOR to delivery to the site, by the soil's testing laboratory for conformance with this specification.

Suggested soils testing laboratories:

A. McNitt & SerenSoil, LLC
306 Ravendale Road
Pennsylvania Furnace, PA 16865
(814) 364-2792 voice/fax

Tifton Labs
1412 Murray Avenue
Tifton, GA 31794
(229) 382-7292

- D. Rootzone Placement - Sand rootzone mixture shall be delivered to the playing field by truck and carefully placed to a depth of ten inches (10") over the approved four inch (4") gravel blanket, the subdrainage piping system, the irrigation system, and the and the 95% compacted subgrade using low ground pressure, wide track equipment (see section 32 18 06). Final depth of rootzone mixture shall be water settled, and compacted depth of ten inches (10").
- E. Infield Clay Placement - Forms for the skinned infield, baselines and homeplate shall be installed per the plans and details provided. Prior to the installation of the skinned infield material, all forms shall be reviewed and approved by the Owner's representative. Approved skinned infield clay shall then be placed to a six inch (6") compacted depth. Laser grade the infield after installation.
- F. Pitching Mound And Homeplate Installation - Forms for the pitching mounds, homeplates for both the main diamond, and the bullpens shall be installed per the plans and details provided. Prior to the installation of the pitching and homeplate mixtures, forms shall be reviewed and approved by the Owner's representative. Approved pitching and homeplate mixtures shall then be placed to the compacted depth of each material listed within the plans and details provided. Playing field contractor shall place mound clays in the respective area as shown on the plans. The Owner's turf manager will be responsible for final shaping of each of the pitching mounds.
- G. Fertilizers - Written bulk fertilizer program will be provided to the playing field contractor by the Owner's representative based upon soils test data provided by the playing field contractor. Broadcast approved specified starter fertilizer blend by truck or power operated machinery. Fertilizer shall be mechanically disced, ripped, or harrowed prior to final finish laser grading, into the ten inch (10") sand rootzone, taking care to maintain finished grades, protecting the irrigation system and all existing features.
- H. Verification - Verify finished grade elevation and depth of rootzone mixture, skinned infield materials, and warning track, utilizing a laser operated survey instruments. Final finish grading of the rootzone mixture, skinned infield materials, and warning track, prior to sodding, shall be accomplished utilizing conical automatic laser operated equipment capable of the following tolerances:

Finished grade elevations of the field shall be within plus 0.00 or minus 0.75inch with no variations of more than 0.25 inch in 25 feet of the designed elevations.

Provide certified as-built drawings of final finished grade elevations to Owner's representative (in PDF format) upon completion, and prior to the installation of the sod. (See spec. 32 18 05 and 32 18 13)

4.2 PROTECTION

- A. General - Provide protection of the sand rootzone playing surface, skinned infield, mound/homeplate area, warning track and bull pens until such time as the sod installation can be performed. This protection shall include tarping of the skinned infield, mounds and homeplate areas of the diamond and bullpens until substantial completion and acceptance of the field by the Owner.

PART 5 - GUARANTEE

5.1 INSTALLATION

- A. Materials shall be guaranteed to conformance with this specification. Final rootzone mixture shall be guaranteed to an initial minimum infiltration rate of 15-25 inches/per hour. It is intended that the field rootzone will percolate at a minimum infiltration rate 5" per hour, after establishment of the turf. Final field percolation rates shall be subject to the proper sod installed (spec. 32 18 13) and maintenance of the system provided by Owner, his heirs or assigns.

END OF SECTION 32 18 11

SECTION 32 18 13 - PLAYING FIELD SOD

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. The work shall include all labor, materials, and equipment necessary to complete the sod growing, harvest, delivery and installation as herein specified.
- B. Related Work:
 - 1. Playing Field Earthwork: Section 32 18 05
 - 2. Playing Field Subdrainage System: Section 32 18 06
 - 3. Playing Field Irrigation System: Section 32 18 08
 - 4. Playing Field Materials and Mixtures: Section 32 18 11

PART 2 - MATERIALS

2.1 PLAYING FIELD SOD:

- A. Sod shall be sand grown Tifway "419" bermudagrass turf, Certified by the United States Department of Agriculture as being true to variety and having a healthy vigorous root system. Sod shall be grown in a similar sand growing medium as the rootzone mixture specified for the playing field. The sand growing medium for the sod shall be at least 90% medium to fine sand and shall have a percolation rate of at least 3" per hour as verified by laboratory testing prior to selection. It is the responsibility of the playing field contractor to verify sand content, and percolation tests prior to bidding the project. No exceptions for percolation rates less than 3" per hour will be considered. (See item B. Below) Bidding contractor shall submit the name of the sod farm at the time of bidding that they intend to utilize for this project.

Suggested materials testing laboratories to be utilized for testing of sand growing medium.

A. McNitt & SerenSoil, LLC
306 Ravendale Road
Pennsylvania Furnace, PA 16865
(814) 364-2792 voice/fax

Tifton Labs
1412 Murray Avenue
Tifton, GA 31794
(229) 382-7292

Suggested (but not limited to) sod farm supplier*:

Sand Hill Sod Farm 800-688-3950

* Suggested sod farms listed above does not preclude the testing requirements listed above, and name is provided for convenience only.

- B. Sod farm/supplier must supply proof that Nematode testing and/or treatment has been performed within the past two years from date of harvest. The sod supplier shall guarantee in writing that the tests are reliable and accurate. The Owner reserves the right to perform a Nematode assessment prior to sod harvest.
- C. Sod shall be healthy, thick turf having undergone a program of regular fertilization and a two-month pre-harvest fertilization program selected by the Architect/Owner's representative. Sod shall be a minimum of one (1) year old at the time of installation.
- D. Bermuda grass sod shall be overseeded with perennial ryegrass at the sod farm on or about September 15, 2013. Scott's Venture Green Pro three way blend of perennial rye overseed shall be applied at the rate of 7 lbs/1000 s.f. and shall be slicer seeded and/or brillion drilled in to the Bermuda grass stand. Sod farm shall verify the perennial ryegrass over seed for approval by the Architect's representative prior to installation.

PART 3 - EXECUTION

3.1 INSTALLATION-PLAYING FIELD

- A. Sod shall be "Jumbo" roll sod, minimum of 42" in width. Sod shall be laid on an approved finished grade that is a smooth, even surface with all joints tightly placed together. Thickness of cut shall be maximum ½" thick sandy soil at the time of cutting.
- B. Sod shall be delivered and installed no more than eight (8) hours from time of harvest. Sod shall be tarped and protected during delivery and shall not be allowed to dry out. Water shall be applied to each individual roll as soon as it is laid, and then by irrigation zone once an irrigation zone is complete.
- C. Any damage to the playing field finished grades from sod laying equipment shall be immediately repaired and hand raked smooth prior to the installation of the sod. Sand rootzone adjacent to the irrigation heads shall be hand raked smooth leaving the top 1/2" of the irrigation head exposed prior to the installation of the sod.
- D. All sprinkler heads will be flagged by the playing field contractor prior to the laying of the sod. The sod supplier/installer shall be required to cut sod away from all sprinkler heads at the time of laying the sod.

- E. All seams and joints shall be filled with sand rootzone material by hand. Any excess rootzone materials evident after hand seaming joints shall be washed off immediately to avoid smothering the turf.
- F. Roll sod two directions with a 6' -8' wide minimum 2000 lb. roller within one week after initial laying. Flag all irrigation heads prior to rolling.
- G. Apply a 21-07-14 starter fertilizer @ 5lbs/1000 s.f. with a micronutrient package (Micropak or equivalent) within 10 days of initial laying of the sod.

PART 4 - GUARANTEE

4.1 SOD GUARANTEE

- A. Sod shall be guaranteed to be in a healthy and vigorous condition at installation and shall be true to name and varieties as indicated by certification by the sod supplier/installer.

END OF SECTION 32 18 13

SECTION 32 19 23 - TREE -PIT ROOT PATH

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Perforated drain lines
 - 2. Strip drains
 - 3. Soil fill material
- B. Related Sections:
 - 1. Division 32 Section "Plants" for trees.

1.3 DEFINITIONS

- A. Root Path: A trench beneath paving or other impervious surface consisting of perforated drain lines, strip drains, and planting soil that allows the tree roots to spread within and beyond the critical root zone.
- B. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- C. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- D. Aeration System: Root path system installed to provide oxygen to tree roots under pavement.
- E. Critical Root Zone: Root mass surrounding a tree that is critical for tree survival. This zone may be larger than the tree canopy (spread).

1.4 PROJECT CONDITIONS

- A. Do not install products or materials that are damaged.

- B. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit trenching operations to be performed.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Strip Drain: Two-part prefabricated soil strip drain consisting of a formed polystyrene core covered on all sides with a non-woven, needle-punched polypropylene filter fabric.
 - 1. Manufacturer: American Wick Drain Corporation
Monroe, NC 28110
704-238-9200
 - 2. Product: AkwaDrain, 12 inches wide
- B. Tape: Polyethylene, 3-inches wide for underground application as supplied by strip drain manufacturer.
- C. Planting Soil: Sandy loam, minimum 4% by weight of organic matter. Free of sticks and other foreign matter deleterious to the soil mix, and no stones greater than 1-inch in diameter. Suitable in composition to sustain plant growth.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine products or materials before installation. Replace materials that are damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Fully compact all subgrade and bring subgrade to designated elevation.
- B. Prior to placing base course and paving or hard surface materials, machine trench a 4 inch deep by 12 inch side below the prepared subgrade.
 - 1. Set top sheet of strip drain flush with top elevation of subgrade.
 - 2. Place drain, fitting against the side and bottom of the trench.

3. Connection

a. Straight Connection:

- 1) Splice strip drain using manufacturer standard connector.
- 2) Place ends of drain no less than 2" into connector.
- 3) Tape connection to hold in place during connection.

4. Where strip drain ends without a connection, seal open end with filter cloth as recommended by the strip drain manufacturer.

C. Backfill with planting soil so that planting soil is placed on both sides of the strip drain using a narrow wooden stick, lightly compact the soil to eliminate air pockets. Do not compact too tightly that water will not penetrate the soil.

D. Using a plate vibrator, run the machine over the area of the root path and along the sides of the trench. Add additional and vibrate again if the soil settles below the top of the strip drain top sheet.

3.3 PROTECTION

A. Protect the root path and planting soil from damage and further compaction until finish top surface is placed.

END OF SECTION 32 19 23

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Chain-Link Fences: Industrial.
 - 2. Gates: Motor operated, swing.
- B. See Division 26 Sections for electrical service and connections for motor operators, controls, limit and disconnect switches, and safety features and for system disconnect switches.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show locations, components, materials, dimensions, sizes, weights, and finishes of components. Include plans, gate elevations, sections, details of post anchorage, attachment, bracing, and other required installation and operational clearances.
 - 1. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
- C. Samples:
 - 1. Polymer-coated steel wire for fabric.
 - 2. Polymer coating on framing and accessories.
- D. Maintenance Data: For gate operator.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. UL Standard: Provide gate operators that comply with UL 325.
- C. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators serving as a required means of access.

- D. Installer Qualifications: Engage an experienced Installer who has at least three years' experience and has completed at least five chain link fence projects with same material and of similar scope to that indicated for this Project with a successful construction record of in-service performance.

1.4 PROJECT CONDITIONS

- A. Field Measurements: Verify layout information for fences and gates shown on the Drawings in relation to the property survey and existing structures. Verify dimensions by field measurements

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

- A. General: 6' High unless otherwise indicated on Drawings. Comply with ASTM A 392, CLFMI CLF 2445, and requirements indicated below:
 - 1. Steel Wire Fabric: Polymer-coated wire, 9 gauge.
 - a. Mesh Size: 2 inches.
 - b. Zinc Coating: 1.2 oz. per square foot min.
 - c. Polymer Coating: ASTM F 668, Class 1 over metallic-coated steel wire.
 - 1) Color: Black, complying with ASTM F 934.
 - 2. Selvage: Knuckled at both selvages.

2.2 INDUSTRIAL FENCE FRAMING

- A. Posts and Rails: Comply with ASTM F 1043 for framing, ASTM F 1083 for Group IC round pipe, and the following:
 - 1. Group: IA, round steel pipe, Schedule 40.
 - 2. Fence Height: 6 feet.
 - 3. Strength Requirement: Heavy industrial according to ASTM F 1043.
 - 4. Horizontal-Slide Gate Post: According to ASTM F 1184.
 - 5. Terminal post to be 3" OD.
 - 6. Line post to be 2-1/2" OD.
 - 7. Top rail to be 1.66" OD.
 - 8. Coating for Steel Framing:
 - a. Polymer coating over metallic coating.

2.3 TENSION WIRE

- A. General: Provide horizontal tension wire at bottom of fence fabric.

- B. Metallic-Coated Steel Wire: 0.177-inch- diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824.
 - 1. Metallic Coating: Type III, Zn-5-Al-MM alloy.

2.4 INDUSTRIAL SWING GATES

- A. General: Comply with ASTM F 900 for single and double swing gate types.
 - 1. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F 1083 and ASTM F 1043 for materials and protective coatings.
 - 2. Metal Pipe and Tubing: Aluminum. Comply with ASTM B 429 and ASTM F 1043 for materials and protective coatings.
- B. Frames and Bracing: Fabricate members from round tubing with outside dimension and weight according to ASTM F 900 and the following:
 - 1. Gate Fabric Height: 2 inches less than adjacent fence height.
 - 2. Leaf Width: 48 inches.
 - 3. Frame Members:
 - a. Tubular Steel 1.90 inches round.
- C. Frame Corner Construction:
 - 1. Assembled with corner fittings and 5/16-inch- diameter, adjustable truss rods for panels 5 feet wide or wider].
- D. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 4 feet wide. Latching mechanism will accept a pad lock for locking gate.

2.5 INDUSTRIAL HORIZONTAL-SLIDE GATES

- A. Existing cantilever slide gate will be removed, stored, and re-installed when appropriate. Rollers and associated hardware will be re-used or replaced as required.

2.6 GATE OPERATORS

- A. General: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.
- B. Comply with NFPA 70.

- C. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG-1 and the following:
 - 1. Voltage: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected..
 - 2. Phase: Three.
- D. Gate Operators: Pedestal post mounted and as follows:
 - 1. Mechanical Slide Gate Operators:
 - a. Duty: Heavy-duty, commercial/industrial.
- E. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with enclosure and with space for additional optional equipment. Provide keyed switch station remote-control device(s).
- F. Radio Control: Digital system consisting of code-compatible universal receiver with transmitter.
- G. Vehicle Detector: Presence system including automatic closing timer with adjustable time delay before closing and timer cut-off switch; designed to open and close gate, and hold gate until traffic clears.
- H. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately reverse gate in both opening and closing cycles and hold until clear of obstruction.
- I. Accessories:
 - 1. Instructional, Safety, and Warning Labels and Signs: According to UL 325

2.7 CAST-IN-PLACE CONCRETE

- A. Materials: Portland cement complying with ASTM C 150, Type I aggregates complying with ASTM C 33, and potable water.
 - 1. Concrete Mixes: Normal-weight concrete air entrained with not less than 3000-psi compressive strength (28 days), 3-inch slump, and 1-inch maximum size aggregate.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install chain-link fencing to comply with ASTM F 567 and more stringent requirements specified.

- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 - 1. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
- D. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment.
- E. Line Posts: Space line posts uniformly at 10 feet o.c.
- F. Post Bracing and Intermediate Rails: Install according to ASTM F 567. Install braces at end and gate posts and at both sides of corner and pull posts.
- G. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing.
- H. Top Rail: Install according to ASTM F 567.
- I. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2 inches between finish grade or surface and bottom selvage, unless otherwise indicated.
- J. Tie Wires: Attach wire per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
- K. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.
- L. Privacy Slats: Install slats in direction indicated, securely locked in place.

3.2 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.3 GATE OPERATOR INSTALLATION

- A. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
- B. Concrete Bases/Pads: Cast-in-place or precast concrete, depth not less than 12 inches, dimensioned and reinforced according to gate-operator component manufacturer's written instructions and as indicated on Drawings.

- C. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

3.4 GROUNDING AND BONDING

- A. Fence Grounding: Install at maximum intervals of 1500 feet.
- B. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet
 - 1. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location.
- C. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
 - 1. Connections: Make connections so possibility of galvanic action or electrolysis is minimized.
- D. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

END OF SECTION 323113

SECTION 323119 - DECORATIVE METAL GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Decorative metal swing gates.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each fence material and for each color specified.
 - 1. Provide Samples 12 inches in length for linear materials.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 STEEL AND IRON

- A. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Tubing: ASTM A 500, cold formed steel tubing.

- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 50, with coating.
- D. Castings: Either gray or malleable iron unless otherwise indicated.
 - 1. Gray Iron: ASTM A 48/A 48M, Class 30.
 - 2. Malleable Iron: ASTM A 47/A 47M.

2.2 COATING MATERIALS

- A. Epoxy Primer for Galvanized Steel: Complying with MPI #101 and compatible with coating specified to be applied over it.

2.3 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.4 DECORATIVE STEEL GATES

- A. Decorative Steel Gates: Fences made from steel tubing bars and shapes, hot-dip galvanized.
- B. Posts: Square steel tubing.
 - 1. Swing Gate Posts: 4 by 4 inches with 3/16-inch wall thickness.
- C. Pickets: 1/2-inch- square steel bars.
- D. Infill: Custom design as indicated on Drawings.
 - 1. Bars: 1/2-inch- square steel bars.
 - 2. Square Tubes: Square steel tubing 2-1/2 by 2-1/2 inches with 1/8-inch wall thickness unless otherwise indicated.
- E. Fasteners: Stainless-steel carriage bolts and tamperproof nuts.
- F. Hardware:
 - 1. Hinges: Extra Heavy duty stainless steel gates hinges capable of supporting gate and operation as indicated.
 - 2. Latches: Locking gate hardware. Provide deadbolt with key cylinder as specified in Section 087111 Door Hardware.
- G. Fabrication: Fabricate bar grating infill into sections of size indicated.
- H. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

- I. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.
 - 1. Hot-dip galvanize posts and rails.
 - 2. Hot-dip galvanize rail and picket assemblies after fabrication.
 - 3. Hot-dip galvanize bar grating infill after fabrication.
 - 4. Hot-dip galvanize custom-design rail and infill assemblies after fabrication.
- J. Finish for Metallic-Coated Steel Items: High-performance coating.

2.5 STEEL FINISHES

- A. Surface Preparation: Clean surfaces according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
 - 1. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
- B. Primer Application: Apply zinc-rich epoxy primer immediately after cleaning, to provide a minimum dry film thickness of 2 mils per applied coat, to surfaces that will be exposed after assembly and installation, and to concealed surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.3 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or

malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

- B. Lubricate hardware and other moving parts.

END OF SECTION 323119

SECTION 32 84 00 - UNDERGROUND IRRIGATION SYSTEM – LANDSCAPE AREAS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK:

- A. Provide a complete automatic operating drip irrigation system including taps, pipes, valves, spray heads, wires, controllers and all excavation and labor involved. This specification is only for landscape areas. This specification is not to be used for the playing field area.

1.02 RELATED SECTIONS:

- A. Plants: Section 32 93 00
- B. Storm Drainage Piping: Section 33 41 00

1.03 QUALITY ASSURANCE:

- A. Provide underground irrigation system as a complete unit with all components produced by a single manufacturer.
- B. Acceptable Installer: A firm with at least two (2) years of successful installation experience on irrigation system projects similar to that shown for this project.

1.04 SUBMITTALS:

- A. Design Drawings: Submit detailed drawings of system including locations, types and sizes of heads, pipes, valves, and controller.
- B. Product Data: Submit manufacturer's technical data and installation instructions for underground sprinkler system.
- C. Maintenance Data: Submit maintenance instructions to Owner upon completion.
- D. Extra parts: Submit two of each type of head, nozzle and special wrenches and quick coupler keys to the Owner.
- E. As-Built Drawings: Submit one paper copy of irrigation plan showing actual installed locations of all valves, heads and pipes.

1.05 REGULATORY REQUIREMENTS:

- A. Work of this section shall comply with all applicable local, state and federal codes.

1.06 WARRANTY:

- A. Warranty parts and workmanship for one year from date of final acceptance.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER:

- A. Manufacturer: Subject to compliance with requirements, provide meeting all applicable codes.
- A. Firms regularly engaged in the manufacturer of outdoor irrigation components of the type and size required for this project, whose products have been in satisfactory use in similar service for not less than five (5) years.

2.02 MATERIALS:

- A. Pressure pipe (upstream from circuit valves): PVC plastic pipe, ASTM D1785, Schedule 40.
- B. Circuit Pipe (downstream from circuit valves): PVC plastic pipe, ASTM D 1785 Class 200.
- C. Pipe fittings: Designed for PVC plastic pipe, ASTM D2466 socket fittings with ASTM D2564 solvent cement.
- D. Drip Emitters: Manufacturer's standard units designed to provide uniform coverage over the entire area of plantings, as shown on the drawings.
- E. Valves: Manufacturer's Standard, of type and size indicated, and as follows:
 - 1. Automatic Circuit Valves: Angle valves operated by low power solenoid, normally closed, flow control adjustment.
 - 2. Manual Valves: Brass Ball valves, size 1" unless otherwise noted.
- F. Valve Box: High impact plastic or composite with cover
- G. Automatic Control System: Furnish manufacturer's standard unit, manufactured expressly for control of automatic circuit valves of underground irrigation system. Provide UL listed unit, properly grounded according to manufacturer's recommendations and local electric codes. Irrigation will be in a confined area and runoff onto the sidewalk will be unacceptable. Unit must be capable of at least two start times per day.
- H. Wire:
 - 1. 120 volt: Code approved 12 or 14 gauge in conduit for power supply to automatic controller
 - 2. 24 volt: Code approved 14 gauge UF direct burial wire, color coded

PART 3 EXECUTION

3.01 PREPARATION:

- A. Contractor shall review drawings and examine the job site to ascertain the location of drives, walks, grades, landscape and buildings. The contractor shall guarantee complete coverage of the irrigated areas.
- B. Contractor shall schedule a pre-installation conference with DBAP Grounds Staff prior to construction.

3.02 TRENCHING AND BACKFILLING:

- A. The area requiring irrigation is also an area of extensive underground utilities. Verify locations of utilities prior to beginning trenching.
- B. Excavate straight and true with bottom uniformly sloped to low points of each circuit.
- C. Trench depth: Excavate trenches to pipe invert. All PVC circuit piping shall have a minimum of 12" of cover
- D. Backfill with clean material from trench, remove organic material as well as rocks and debris larger than 1" diameter. Place backfill in 6" lifts, compacting each lift.

3.03 INSTALLATION:

- A. Connect to water system as indicated on drawings.
- B. Maintain uninterrupted water service to building during normal working hours. Arrange for temporary water shut-off with owner if needed.
- C. Backflow preventer: Provide union on downstream side. Install per local requirements.
- D. Circuit valves:
 - 1. Install in valve boxes, ganged together for easy access and adjustment.
 - 2. Provide union on downstream side.
 - 3. Adjust each valve to provide flow rate of rated operating pressure required for each circuit.
- E. Piping:
 - 1. Lay pipe on solid subbase, uniformly sloped without humps or depressions
 - 2. For circuit piping slope to drain valve at least ½" in 10' of run.
 - 3. At wall penetrations, pack the opening around the pipes with no-shrink grout. At exterior of wall, leave depression ½" to ¾" deep and fill with backer rod and sealant.
 - 4. Install PVC piping in dry weather when ambient temperature is above 40 degrees F. in strict accordance with manufacturer's instructions. Allow joints to cure at least 24 hours at temperatures above 40 degrees F. before testing, unless otherwise recommended by manufacturer.
 - 5. Flush circuit lines with full head of water prior to installing sprinkler heads.
 - 6. Polyethylene tubing used in connecting sprinkler heads to pvc circuit lines shall be no longer than 18".
- F. Drip Emitters:
 - 1. Locate to maintain a minimum distance of 4" from walls and 2" from other boundaries.

3.04 TESTING:

- A. General: Notify Architect in writing when testing will be conducted. Conduct tests in presence of Architect.

- B. Hydrostatic Test:
 - 1. Test water piping and valves, before backfilling trenches, to a hydrostatic pressure of not less than 100 psi for one hour with no pressure loss.
 - 2. Piping may be tested in sections to expedite work.
 - 3. Remove and repair piping, connections and valves which do not pass hydrostatic testing.
- C. Operational Testing:
 - 1. Perform operational testing after hydrostatic testing is completed, backfill is in place and sprinkler heads adjusted to final position.
 - 2. Demonstrate to the Architect that the system meets coverage requirements and that automatic controls function properly.
 - 3. Coverage requirements to be based on operation of one circuit at a time.

3.05 ACCEPTANCE/MAINTENANCE:

- A. Notify the Architect that the installation is complete and ready for inspection.
- B. If final acceptance is not given, the Architect will prepare a punch list, and re-inspection will be made once all items are corrected.
- C. Provide complete operation and maintenance instructions, including winterizing procedures, for the Owner including the seasonal circuit operation timing for the system
- D. Maintain the system in repair and good condition for 90 days from date of final acceptance at no cost to the Owner.

END OF SECTION 32 84 00

SECTION 32 93 00 - PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.
3. Trees.
4. Shrubs.
5. Ground Cover

1.2 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than sizes indicated diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied rigidly supported and drum laced as recommended by ANSI Z 60.1.
- C. Container Grown Stock: Healthy, vigorous, well rooted exterior plans grown in a container with well established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type and size of exterior plant required.
- D. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- E. Finish Grade: Elevation of finished surface of planting soil.
- F. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- G. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- H. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

- I. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- J. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- K. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- L. Weeds: Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Ivy, Blackberry, Tansy, Ragwort, Bermuda Grass, Johnson Grass, Poison Oak, Nut Sedge, Nimblewill, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated, including soils.
- B. Planting Schedule: Indicating anticipated planting dates for landscape plants.
- C. Product certificates.
- D. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year.

1.4 QUALITY ASSURANCE

- A. Installer's Qualifications: A qualified landscape installer who maintains an experienced full-time supervisor on Project site when exterior planting is in progress. The Contractor performing work in this section shall have at least 3 years experience of successfully completing jobs of a similar type.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- C. Plant material and installation methods shall comply with City of Durham Planning Department "Landscape Guidelines", August 2, 2006 edition.
- D. Preinstallation Conference: Conduct conference at Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver bare-root stock plants freshly dug. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.
- B. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- C. Handle planting stock by root ball.
- D. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.
- E. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
 - 1. Set balled stock on ground and cover ball with soil, peat moss, saw dust or other acceptable material
 - 2. Do not remove container grown stock from containers before time of planting.
 - 3. Water root systems of exterior plants stored on site with a fine mist spray. Water as often as necessary to maintain root systems in a moist condition.
- F. Deliver fertilizer to site in undamaged waterproof bags showing manufacturer, weight, and analysis.

1.6 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
 - b. Structural failures including plantings falling or blowing over.
 - 2. Warranty Periods from Date of Substantial Completion:
 - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
 - b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
 - c. Annuals: Three months.

- d. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season.
 - e. Replace exterior plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
- 3. A limit of one replacement of each exterior plant will be required except for losses or replacements due to failure to comply with requirements.

1.7 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain during warranty period by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, tightening and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees and shrubs free of insects and disease. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.
 - 1. Maintenance Period for Trees and Shrubs: 12 months from date of Substantial Completion.
 - 2. Maintenance Period for Ground Cover and Other Plants: Six months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
- B. Tree and Shrub Material: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement. Plant sizes at installation are indicated on the contract drawings.
 - 1. Provide balled and burlapped trees, and container-grown shrubs.
 - 2. Label at least one tree and shrub of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.

- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.

2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 - 1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.
 - 2. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through No. 60 sieve.

2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or granular texture, with a pH range of 3.4 to 4.8.

2.4 FERTILIZERS

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

2.5 PLANTING SOILS

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.
 - 1. Topsoil Source: Topsoil is not available at the site and must be furnished as specified.
 - a. Provide new topsoil which is friable, fertile, natural loam high in organic content and free of lumps, rocks, weeds, brush, roots, stumps or any toxic matter injurious to plants. Obtain topsoil displaced from naturally well drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural lands, bogs or marshes.
 - b. Manufactured Topsoil to be Triangle Landscape Supplies 50/50 Blend or approved equivalent
- B. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 2 percent organic material content. Verify suitability of soil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
 - 1. Ratio of Loose Compost to Topsoil by Volume: 1:3.
 - 2. Ratio of Loose Peat to Topsoil by Volume: 1:5.
 - 3. Weight of Lime per 1000 Sq. Ft.: 30
 - 4. Weight of Bonemeal per 1000 Sq. Ft.: 18 lbs.
 - 5. Weight of Commercial Fertilizer per 1000 Sq. Ft.: 4 lbs.

2.6 MULCHES

- A. Organic Mulch: Shredded hardwood mulch, composted and free of growth or germination inhibiting ingredients and free of noxious weed seeds.

2.7 ACCESSORIES

- A. Flagging Tape: Polypropylene flagging material shall be a minimum of 6" long. Tape color shall be orange for the entire project area. The tape color shall meet pedestrian visual safety requirements for day and night.
- B. Antidesicant: Water insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed and fully labeled containers and mix according to manufacturers written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements and other facilities and lawns and existing exterior plants from damage caused by planting operations.
- B. Lay out individual tree and shrub locations and areas for multiple exterior plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architects acceptance of layout before planting. Make minor adjustments as required.

3.3 PLANTING AREA ESTABLISHMENT

- A. Loosen subgrade of planting areas to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Apply fertilizer directly to subgrade before loosening.
 - 2. Thoroughly blend planting soil off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
 - 3. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet. Incorporate the planting soil mix into the top 8-12 inches of planting areas.
- B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- C. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on

undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter.

3.5 TREE, SHRUB, AND VINE PLANTING

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.
- B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Set stock plumb and in center of planting pit or trench with root flare 3 inches adjacent finish grades.
 1. Balled and Burlapped: After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 2. Container-Grown: Carefully remove root ball from container without damaging root ball or plant. Scarify sides of rootball prior to planting.
 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 4. Continue backfilling process. Water again after placing and tamping final layer of soil.
 5. Guy and Stake as required.
- D. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 TREE, SHRUB, AND VINE PRUNING

- A. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character. Prune trees to retain required height and spread. Shrub sizes indicated are sizes after pruning.

3.7 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on contract drawings in even rows with triangular spacing.

- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots, and backfill with planting soil.
- D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
 - 1. Trees and Tree-like Shrubs in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 12-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.
 - 2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.10 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. During landscape work keep pavements clean and work areas in an orderly condition.
- D. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

3.11 INSPECTION AND ACCEPTANCE:

- A. The landscape architect will be notified at least 24 hours in advance of the delivery of plant material to the site, for inspection prior to planting. The Owner reserves the right to monitor the work in progress and to inspect any and all work records kept by the Contractor or subcontractor at any time during the course of the Contract. Inspection

will also be made at the completion of the project. Remove all tags, labels, strings, etc from the plant after it is inspected.

- B Notify the landscape architect when the landscape work is completed to request an inspection to determine acceptability.
- C When landscape work does not comply with requirements, replace rejected work and continue specified maintenance until re-inspected by Landscape Architect and found to be acceptable. Remove rejected plants and materials promptly from the site.
- D Notify landscape architect of completion of rejected items and schedule re-inspection.

END OF SECTION 329300

SECTION 33 41 00 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes gravity-flow, nonpressure storm drainage outside the building, with the following components:
 - 1. Cleanouts.
 - 2. Precast concrete manholes.
 - 3. Catch basins, yard inlets, and curb inlets.
 - 4. Reinforced concrete pipe.
 - 5. Roof drainage connections.
 - 6. High density polyethylene (HDPE) pipe

1.2 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure, Drainage-Piping. Piping will meet the requirements of City of Durham Standard Specification and the North Carolina Department of Transportation. All storm drainage materials and installations shall meet the requirements and specifications of NCDOT and the City of Durham.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For pipe, manholes, and catch basins. Include plans, elevations, sections, details, and manhole frames and covers and catch basin frames and grates.
- C. Coordination Drawings: Show pipe sizes, locations, and elevations.
- D. Field quality-control test reports. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.2 REINFORCED CONCRETE PIPE

- A. Pipe and Fittings: ASTM C 76, Class III, unless otherwise noted.
- B. Gasket and Joint: Watertight per ASTM C 443
- C. Meet all aspects of the requirements of N.C. Department of Transportation.
- D. Flared End Sections (FES) will be in conformance with Section 1032-9(D) of the 2002 North Carolina Division of Transportation Standard Specifications for Roads and Structures

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class Service and Extra-Heavy classes Extra-Heavy class.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HDPE PIPE AND FITTINGS

- A. Corrugated Double Wall HDPE Drainage Pipe and Fittings NPS 10 and Smaller: AASHTO M 252M, Type S, double wall pipe with smooth pipe interior with smooth waterway for coupling joints and silt tight joints or better.
- B. Corrugated Double Wall HDPE Pipe and Fittings NPS 12 and Larger: AASHTO M 294M, Type S, double wall pipe with smooth interior with smooth waterway for coupling joints and silt tight joints or better.

2.5 PVC PIPE AND FITTINGS

- A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 1784, Schedule 40 with solvent weld joints. Install solvent weld joints per manufacturer's recommendations.
- B. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM D-3034 SDR 35, Type PSM sewer pipe and fittings with bell and spigot joints with rubber gaskets which conform to ASTM F 744.

2.6 MANHOLES

- A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

1. Diameter: 48 inches minimum, unless otherwise indicated.
2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
3. Base Section: 6-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
4. Riser Sections: 5-inch minimum thickness, and of length to provide depth indicated.
5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
8. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
9. Manhole Frames and Covers: Ferrous meeting the requirements for sanitary sewer manholes except for words equivalent to "STORM SEWER."

2.7 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
 1. Cement: ASTM C 150, Type II.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.
- B. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water-cementitious materials ratio.
 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.8 CATCH BASINS

- A. Standard Precast Concrete Catch Basins: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 1. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
 2. Top Section: Eccentric-cone type unless flat-slab-top type is indicated.
 3. Joint Sealant: ASTM C 990, bitumen or butyl rubber.

- B. Frames and Grates: Cast iron suitable for structural loading.
 - 1. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
 - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
 - a. Flexible couplings for same or minor difference OD pipes.
 - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
- B. Gravity-Flow, Nonpressure Sewer Piping: Use the following pipe materials for each size range:
 - 1. Class 3 reinforced concrete pipe, unless otherwise noted .

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
 2. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
 4. All pipe will be installed per Section 300 of the NCDOT Standard Specifications for Roads and Structures, January 2002 edition.
- F. Clear interior of piping and manholes of dirt and superfluous material as work progresses.

3.3 PIPE JOINT CONSTRUCTION

- A. Basic pipe joint construction is specified in Division 33 Section "Common Work Results for Utilities." Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
- B. Join gravity-flow, nonpressure drainage piping according to the following:
1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
 3. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
 4. Install RCP and HDPE pipe in accordance with City of Durham Specifications and NCDOT requirements.
 5. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 1 inch above finished surface elsewhere, unless otherwise indicated.

3.5 CATCH BASIN INSTALLATION

- A. Set frames and grates to elevations indicated.

3.6 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."
- B. Make connections to existing piping and underground manholes.

3.7 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate report for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.

END OF SECTION 334100